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ELECTRICAL PROGRESS IN 1884.

IF the year which has just closed has proved a disappointment to many sanguine investors in electrical enterprises, they may reflect that they are not alone in failing to realize their highest anticipations. So far as invention is concerned, however, every failure marks the general progress of the arts; therefore we may safely assume that whatever the record, there must be general advancement.

The year opened with a multiplicity of claimants to a share in the rich harvest which is being gathered by the American Bell Telephone Company. These various movements have had their thousands of sympathizers, their hundreds of supporters, and doubtless their scores of victims. Many were actuated by hope of legitimate gain, others by what they believed to be a sense of justice, while it is not unlikely that a few shrewd minds scented a field for possible plunder. Temporary encouragement was derived, on January 25, from the refusal of Judge McKennan in the United States Circuit Court at Philadelphia, to grant an injunction against the Overland Telephone Co., in view of the near approach of the Bell-Drawbaugh trial in New York city. The decision in the latter case just rendered by Judge Wallace will doubtless cause embarrassment in the procurement of the funds necessary to sustain further speculative enterprises of this character. It is a fair presumption that the removal of all uncertainty as to the future status of the Bell patents will develop renewed activity in the extension of telephone facilities.

The agitation of the question of underground wires has been felt in various parts of the country, and those of our readers who have watched our correspondence may consider themselves tolerably well informed in respect to the actual progress made toward placing electrical wires underground. We regret to be obliged to say that this question has not by any means been fairly treated by the public press, nor have the laws which have been passed evinced any particular disposition on the part of legislators to bring about the desired reform without seriously interfering with various branches of electrical business, which certainly cannot withstand the burden which is about to be forced upon them. Actual progress has been made in placing wires underground in New York, Brooklyn, Chicago, Philadelphia, Pittsburg, Boston and Washington, but it is highly improbable that the requirements of the statutes will be complied with in any of these cities upon the dates fixed by law.

Electric lighting is slowly emerging from the stage of sensational speculation which attended its earlier period of development, and those companies which have survived the ordeal of active competition are gradually building up a substantial legitimate business based upon the merits of their respective systems. The arc lamp has fairly established its reputation as an effective and comparatively cheap method of illumination for large areas, and its use in New York city is very extensive for street lighting, where over 3,700 gas lamps have been displaced by it. Its value for lighthouse purposes is being practically tested by its adoption for use at the recently completed tower on Hallett's Point, Hell Gate channel, the eastern entrance to New York harbor.

The superiority of the incandescent lamp for interior illumination is now admitted, even by those whose interests would naturally lead them to oppose it. For the safe, effective and healthful lighting of vessels, it supplies a want which had never been adequately met. As a competitor of gas on equal terms, for ordinary house-to-house lighting, it has thus far failed to achieve financial success. The most decisive improvement in electric lighting which has been made public during the year is unquestionably the mammoth incandescent lamp invented by Edward Weston, and first shown at the Philadelphia exhibition.

The electrical transmission of power has not as yet been very extensively applied, but its successful future is looked forward to with great confidence by those who are

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best qualified to judge of its numerous advantages. Should it be substituted for steam on one of the lines of the elevated railways in New York city, there will be little question as to its prompt appearance in various other channels of usefulness.

Although numerous changes have taken place in the relative attitudes toward each other of the "opposition" telegraph companies, in the matter of pooling arrangements, and business partnerships, they now stand in this respect just where they did one year ago. The bankruptcy of the Bankers and Merchants' Telegraph Company has been the ostensible reason for the disruption of the working agreement between them, although the war in rates has doubtless caused a diminution in receipts which has been detrimental to the interests of all. The four rival companies are now being operated independently of each other, a state of affairs which is not likely to continue through another year.

The International Electrical Exhibition at Philadelphia, the first of its kind in America, afforded an opportunity for the convenient examination of the most interesting achievements in the field of electrical science. It was well patronized and proved a financial success, although two weeks' receipts were practically lost by reason of the exhibits not being wholly in readiness until that length of time had elapsed.

The American Electrical Exhibition is now in progress in Boston.

The World's Fair which is now open at New Orleans will also embrace some important electrical features, the starting of the machinery by an electrical impulse at the hand of President Arthur at Washington, 1,200 miles away, being an event which, perhaps, gives a popular idea of electrical power transmission. As a matter of record, however, we must state as a fact, that the steam was turned on by hand, in the ordinary manner, when the signal was received.

Among the deaths of the year was that of Th. Achille-Louis Du Moncel, more familiarly known in electrical circles as Comte Du Moncel. He had been for over 30 years an industrious experimenter and author, his literary work being of an especially popular character. At the date of his death he was the scientific editor of *La Lumière Electrique*, to which he contributed many interesting and important papers.

The eminent English electrician, Robert Sabine, died on the 25th of October. Although not a voluminous writer, his ability was recognized as of a practical and useful character, and he was among the earlier of the authors who have left a lasting impression upon the minds of our oldest American electrical students.

THE DECISION IN THE TELEPHONE CASE.

On the 1st of December Judge Wallace of the United States Circuit Court handed in a decision in the case of the American Bell Telephone Company against the People's Telephone Company in favor of the complainants, thus terminating, at least for the present, the legal proceedings which have been in progress for more than four years, and sustaining the preliminary injunction against the People's Telephone Company which was obtained some two years ago. The interest excited by this important case, especially in electrical circles, has been so great and so wide-spread that we have felt constrained to publish it elsewhere in full, notwithstanding its unusual length. The oral arguments before Judge Wallace occupied nine days. The following eminent counsel took part in the proceedings: J. J. Storrow and Chauncey Smith, of Boston; E. N. Dickerson and Roscoe Conkling, of New York, on behalf of the complainants, and Lysander Hill and Hon. George F. Edmunds on behalf of the defendants. The experts retained by the complainants were Charles R. Cross, of Boston, and Frank L. Pope, of New York, and by the defendants, Park Benjamin, of New York. The witnesses who testified for the complainants were 169 in number and their depositions occupied 2,493 printed octavo pages, besides 1,047 pages of exhibits, while 366 witnesses testified for the defendants, filling 2,476 pages of testimony and 160 pages of exhibits, making 6,456 pages in all, constituting eight large volumes.

Two months ago, after all the arguments on both sides had been closed, and the evidence had been placed in the hands of the Court, we published an article containing a careful review of the basis of the defence—the claim of Daniel Drawbaugh—in the light of the evidence which had been taken on both sides. In this article the opinion was expressed that the testimony, taken as a whole, failed utterly to prove the existence of any operative electrical telephone in the hands of Drawbaugh, prior to the date of the invention of Bell. We also editorially expressed the opinion that the claimant, Drawbaugh, and the multitude of witnesses who testified in his behalf, had failed to make out a case which could by any possibility be sufficient to overthrow the Bell patent, and furthermore that the case, taken as a whole, indicated the existence of one of the most extraordinary and widespread conspiracies for the purpose of destroying a patent which had ever occupied the attention of the court of justice. In making these remarks we simply expressed our views and opinions as to what the decision of the Court would necessarily be, in view of the law, of the evidence, and of previous decisions of the Federal Courts in similar cases. Our course in this matter has been severely criticised by a contemporary, who is apparently deeply interested in the success of the scheme of the People's Telephone Company, apparently upon the ground that it was an attempt made in behalf of the Bell "monopoly" to influence the decision of the Court. Since the opinion of Judge Wallace has been made public the same journal has reiterated the charge, and has more than intimated that a certain coincidence which it pretends to have discovered between the view of the evidence taken by us and that taken by Judge Wallace indicates that by corrupt means we were permitted to learn in advance what the opinion of the Court was to be. It is needless to remark that such a charge is utterly false, and a most unjustifiable attack upon the character of a Judge whose absolute integrity has never before been questioned.

In so far as our published views can be shown to agree with those subsequently put forth by the Court, it should rather be taken as a compliment to ourselves than as a ground for condemning the Court.

We said that the evidence indicated the existence of a conspiracy. It is not difficult to gather from the language

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of the decision, that the Judge is of much the same opinion. He says: "It is either true that Drawbaugh had long been treading his solitary path of investigation and experiment in poverty and obscurity, and had perfected his work when the inventions of other explorers were in embryo, *or his story is an ingenious fabrication.* And as will hereafter appear, if the defence is a fabrication, many disinterested witnesses have contributed innocently to give it color and strength, but Drawbaugh *has deliberately falsified the facts.*"

"It is impossible, however, to believe that Drawbaugh can be mistaken in the substance of his testimony, and the conclusion cannot be ignored that *either his testimony is true in its essential parts, or his narrative has been manufactured to fit the exigencies of the case.*"

Assuming the story of Drawbaugh to be true and that he had actually completed and publicly operated electric speaking telephones prior to March, 1876, it became absolutely essential to account for the fact that he omitted to apply for a patent and remained silent for years, while others were appropriating the fame and profits of the invention. The only possible explanation—that of extreme poverty—was set up in the defendants' answer and was attempted to be established by Drawbaugh's testimony. After summarizing his own evidence and that of others on this point, the Court reaches the conclusion, from a few plain facts, that "the theory of extreme poverty is unfounded, and *that Drawbaugh is dishonest in putting it forward,*" and proceeds to sum up the whole matter as follows:

> Where a witness falsifies a fact in respect to which he cannot be presumed liable to mistake, courts are bound upon principles of law, morality, and justice to apply the maxim *falsus in uno, falsus in omnibus.* Drawbaugh could not be mistaken in asserting that it was his poverty which prevented him from caveating or patenting his invention. He was not led to the assertion inadvertently. Those with whom he is associated in the defence understood fully, and so did he, that the fact that a professional inventor and patentee did not go to the Patent Office to secure an invention like the telephone for ten years after it had been completed and demonstrated, was almost conclusive against the theory that he had made the invention, and that unless this presumption could be parried no Court would credit his story. The theory of constraining poverty was therefore formulated in the answer, elaborately fortified by witnesses, and testified to by Drawbaugh. It is overthrown by a few plain, indisputable facts, and Drawbaugh's veracity falls with it.

The Court seizes upon the autobiography of Drawbaugh, prepared by him for publication in the *History of Cumberland County,* as a graphic picture of the inventor and of the man. This is quoted in the opinion, but one or two extracts will suffice. He describes himself as follows: "One of the greatest inventive geniouses (*sic*) of this age (so prolific of great men), who has spent the greater portion of an active life conceiving and producing, as a result of the conceptions of an unusually fertile brain, a score of useful machines and devices." After giving a list of his achievements it concludes: "We are proud to own Mr. D. as a citizen of our township, and deem him worthy of a position at the head of the list of our prominent men, and are hapy (*sic*) to accord him that position."

The Court appropriately remarks that "this portrait, drawn by himself, depicts, without the aid of extrinsic evidence, the ignorance and vanity of the man, and the incongruous and fantastic assortment of his inventive projects. It suggests also the character of a charlatan."

We do not think we do the responsible authors of this scheme any injustice when we again characterize it as a gigantic conspiracy. The parties to it commenced operations by deliberately infringing a patent which had proved very profitable to its owners. An action being brought against them they cast about for a defense, and in some way, with the assistance of able, and it would seem not over-scrupulous attorneys, discovered a fitting tool for their purposes in Drawbaugh, and by working upon his vanity and cupidity, persuaded him, though not without manifest reluctance, to come into court and tell a carefully concocted story of his invention of the electric telephone. It is a significant fact that Mrs. Drawbaugh, who might naturally be expected to be the most earnest, persistent and enthusiastic supporter of her husband's claims, if they were just, has not appeared as a witness. We entertain no doubt that many of the witnesses, in fact the majority of them, were honestly mistaken in their testimony and in their dates, but there are others of whom this charitable view cannot be taken. They were all naturally more or less influenced by that local pride which is always so intense in isolated and comparatively unintelligent communities, to make out as good a case as their consciences would permit for one of their own number. This sentiment was evidently worked upon to the utmost by the attorneys for the defense, and their labors were attended with a degree of success not a little surprising.

It is not probable that the projectors of this fraud had the least idea at the beginning that it would ever have to undergo the searching ordeal of a trial in a Federal Court. They doubtless assumed that the owners of the Bell patent, rather than run the risk of having an invention of such enormous pecuniary value thrown open to the world, would be only too willing to compromise the case for a handsome sum. Many rumors have been published from time to time in reference to efforts said to have been made in that direction. It is almost needless to say that such a policy would have been simply suicidal. The moment Drawbaugh was disposed of a swarm of new claimants of the same character would have arisen. The complete overthrow of this precious scheme—for we think there is no possibility of the reversal of this decision by the Supreme Court—will probably leave the American Bell Telephone Company practically undisturbed in the enjoyment of its possessions at least until the expiration of its principal patents.

ELECTRICITY ON THE ELEVATED RAILROADS.

We remember a story of an occurrence which took place once upon a time upon a railroad which had been "reorganized." There was a new superintendent and a new engineer; there was also an old master-carpenter, but he was a relic of the departed administration. One day the new superintendent sent for the old master-carpenter, and said to him: "I have just received a despatch that the bridge at X—— has been burned; I have directed our engineer to complete the plans for a new bridge at the earliest possible moment. The plans ought to be in your hands

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by to-morrow morning. Have your men ready to go to work the instant you get them, and do not lose a moment in getting the bridge ready for the passage of trains." The old master-carpenter gravely bowed, and withdrew from the presence. The next morning he presented himself at the superintendent's office, and was asked by that functionary whether the plans for the bridge had yet been delivered to him, to which he made answer : "The bridge is all done, sir, and the trains have been running over it since daylight. I haven't seen nothing of the pictur yet."

The condition of affairs in respect to the proposed employment of electricity to operate the elevated railroads in New York city reminds one of this story. We have been informed by the daily press at regularly recurring intervals of the proceedings which have taken place at a series of meetings lately held at the residence of an eminent engineer and patent attorney in this city, and attended by representatives of various inventions for operating railroads by electricity. We have also been informed that it is proposed to "institute a series of experiments" upon the Second Avenue railroad, in which the several competitors are to be allowed to participate, principally at their own expense, on the condition that their inventions are subsequently to be turned over to a "consolidated company," to be formed for the purpose of monopolizing all the electric railroad patents worth having. We are told that the proportion of stock which the competitors are to receive in this consolidated company in payment for their respective interests is to be determined by a "board of arbitrators," composed, as our esteemed contemporary the *Electrical World* expresses it, of "one very eminent non-resident expert, three absolutely inexpert officials, and one pre-eminent expert absent foreigner."

If this remarkably ingenious and original scheme is ever carried forward so far as the point where the board of arbitration decides "without appeal" upon the comparative value of the different inventions, the scientific world will witness an electrical row of unprecedented dimensions ; but we hardly think it will ever get so far as that. Long before this board of eminent *savans* get their "pictur" completed, we shall probably have electric railroads in successful operation in nearly every country in the world. In fact, we already have the Portrush railroad in Ireland, which is as long as the Second Avenue line, and which has been in successful operation, carrying on a regular traffic the same as any other railroad, for a year or more, and moreover, as we are informed, earning a 12 per cent dividend. It is no doubt true that the mechanical and electrical arrangements of the Portrush railroad would be unsuitable, without material modification, for the elevated railroads of New York city, but the results which have been obtained by it prove conclusively the practicability of the system, and what is more important, the possibility of operating it continuously at a profit.

Apparently the only thing that really needs to be done is to place the elevated railroad problem in the hands of some electrical engineer of experience and ability for solution. There is no lack of this class of talent to be had in this country, although we do not find it represented on the "board of arbitration" above spoken of. In our opinion, the managers of the elevated railroads would find no difficulty in negotiating a contract with the United States Electric Lighting Co., the Edison Electric Light Co., or several other corporations or persons that might be mentioned, who are accustomed to deal with such problems, and would undertake to operate the elevated roads with much greater convenience, economy, and safety than is possible under the present system. We do not, in short, think that anything of importance is likely to be accomplished within a reasonable time in any other way.

ARTICLES.

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 269, Vol. III.)

It is not therefore advisable with our present knowledge to use compound aerial cables of greater length than 2 miles for telephonic exchange purposes. When cables of any length between 500 feet and 2 miles are employed, if they are of the rubber or kerite insulation, the Foucaut arrangement should be applied in some form ; and finally if cables are to be used for private lines, or for any purposes not connected with telephone exchanges, and where expense is not a factor, the use of the twisted or closely adjacent metallic return is here strenuously advocated, as a much greater length of cable can thus be employed ; induction being practically eliminated ; and retardation being by no means so pronounced as when the other remedies are employed.

JOINTS OR SPLICES.

The method of making joints or splices in gutta-percha covered conducting wires of aerial or sub-aqueous cables is so succintly described in many text-books that it is quite unnecessary to describe it here. For rubber or kerite cables, it is requisite only to strip off the insulation from the required conductor at the ends to be spliced, and to brighten and thoroughly clean the copper, then to make a long and close twist, after the style of an office wire splice, after which the joint should be soldered and made smooth, and finally covered with good kerite tape. There is a very objectionable kind of tape which is now being liberally bought by persons who know nothing of the demands of good construction (company purchasing agents *et al.*), simply because it is cheap ; and which is sold with corresponding liberality, by dealers who do not care to possess the reputation of selling only good articles, because their customers ask for cheap grades. It will someday be found that in electrical construction only the best materials are cheap.

When a conductor in a paraffine cable is to be spliced, it is necessary to cut the lead covering completely back, until it is found that the core is quite free from moisture ; this can easily be ascertained in the following manner : Melt paraffine in any suitable vessel, and heat it to a temperature of at least 260° F. If now the end of the cable when cut back be dipped in the heated paraffine, bubbles will arise, if the cable is damp. If dry, none will appear. Should bubbles appear, the core must be cut back still farther, until they appear no longer. Separate the conductors, and then splice them in the manner indicated in figure 1. By this kind of a splice we are enabled to join a large number of wires, and draw all equally tight. Joints in paraffine cable conductors should not be soldered, as some hot solder will almost certainly drop among the other conductors, and prove injurious to the insulation. Neither should kerite or rubber tape be placed round the

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joints. The best way of protecting such a splice in this kind of cable, is to draw over one of the divided ends, before the splice is made, a sleeve of braided cotton, which may then be drawn back over the naked wires after the

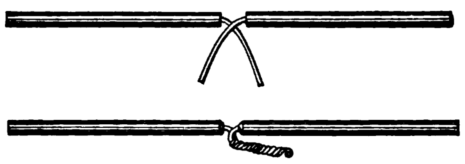

FIGURE 1.

joint is finished. After the conductors are all joined, they may be wrapped together with cotton yarn, twine, or hemp packing, after which paraffine should be heated as before, and poured over the combined splice, until bubbles no longer appear. At the end of a cable, the whole may now be wrapped again with twine. If the joint is made of the entire cable at some intermediate point, the cable must first be opened by carefully cutting round it with a knife or saw, taking care not to cut through. When the lead is nearly cut through, it will easily break.

A sleeve of pipe a little longer than the cable pipe, and long enough to cover the proposed splice, and lap 3 or 4 inches over at each end, should now be slipped over one end, and when the conductors are all joined, and paraffined as we have described, the sleeve can be drawn forward over the splice and joined to the cable pipe by a wipe joint using fine solder.

TERMINAL CONNECTIONS AND LIGHTNING ARRESTERS.

It is very necessary where aerial cables are used, to provide a suitable connection at the outward end for the attachment of the cable conductors to the line wires, and at both ends to attach lightning arresters. We show one very good style of pole box, into which the cable is led intact. The wires are then fanned out to each side and separately terminate at binding screws, which are placed on a bar in a row. The pole line wires enter at each side,

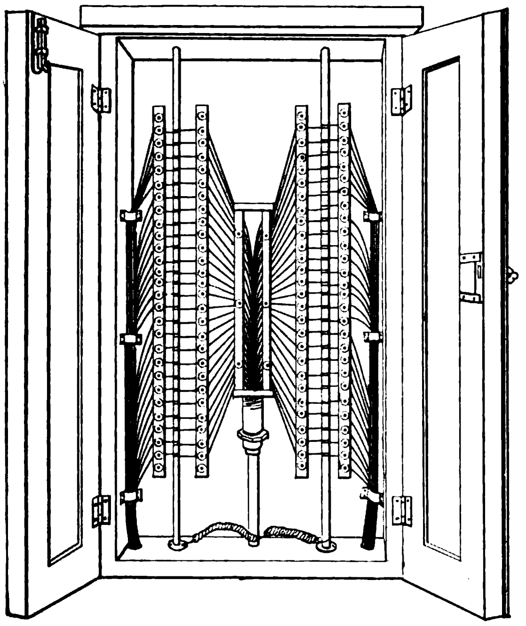

FIGURE 2.

and are terminated in the same way. A metal bar extends on each side between the pole line, and cable line screws, and each pair of terminals is connected by a little piece of comparatively fine wire, which is twisted once round the interposed metal bar. The metal bars being connected with the ground, serve as lightning arresters, and the short pieces are easily renewed.

Where aerial cables run near electric light wires, fusible links, such as narrow strips of tinfoil should, in addition to the lightning arresters, be placed in the line circuit, as electric light currents with a much lower electromotive force than lightning, have great heating power, and would soon destroy a telephone cable.

TESTING INSULATED CONDUCTORS IN CABLES BY MAGNETO BELL.

We have known many persons who were in the habit of testing cable conductors for insulation by ringing a magneto-bell into it, the conductor meanwhile being open at the distant end. As a matter of fact which should be well known, a magneto-generator sending alternating currents will ring its own bell as well on an open as on a closed wire, if the insulation is what it ought to be ; and for this purpose a magneto-bell though almost too handy should not be used. If the insulation is good, the first pulsation sent by the generator may not be sufficient to move the armature, but the second being of opposite direction, having not only to charge the wire but first to neutralize the charge already there, may be strong enough, and the bell rings. On the contrary, if the insulation is not up to the mark, the first charge leaks out before the second comes in and the bell does not ring, except in case the insulation is very low indeed, and then it rings on the escape.

A 50-cell chloride of silver battery, and a magneto-telephone serve to test a cable very well, if the insulation is normally high. Grounding one pole of the battery, we connect the other pole to one of the telephone terminals, and a wire to the other telephone terminal. Now, if we touch the free wire to the end of the cable wire, if the said wire is perfectly insulated, we hear a click, the loudness of which depends on the length of the wire. This click arises from the rush of electricity through the telephone to charge the cable. Now, if the wire be touched a second time no click will be heard because the wire is charged. If the insulation is deteriorating the charge will leak out before the second touch, so that a very perceptible click will be heard the second time. This test, of course, only tells whether the insulation is or is not falling; but if that is once ascertained, the insulation resistance can then be measured. In testing for a break in the same manner, a little experience soon enables one to tell from the sound of the click, the approximate location of the break.

In addition to aerial cables, the constructor is frequently called upon to use office cables. These are usually cables consisting of any required number of wires insulated to a greater or less degree, and covered ordinarily with a cotton braid. If a more ornamental appearance is desired, a silk covering is added. The purpose of these cables is merely a concentration of conductors, so as to economize space, and no special mention of them at this time seems to be required. It will be necessary to refer again, hereafter, to aerial cables when the several methods of suspension will be described.

Before leaving the subject of line wire, it may be mentioned that a line of copper wire built November, 1877, was taken down in August, 1884, and was found to be scarcely diminished in size, and in no way oxidized. This wire was drawn to a degree of hardness which would admit of the regular telegraph twist joint. The line in question was built at Ansonia, Conn., and demonstrates beyond a doubt that hard copper wire (for short lines at all events) will " stand up," that it does not stretch unduly, and that it is not affected in an equal degree with iron, by atmospheric or gaseous agencies.

(To be continued.)

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ELECTRICAL MOTORS AND THEIR CONSTRUCTION.[1]

BY JOHN E. CHASTER.

It is proposed in the present series of articles to give full working drawings and descriptions of an electrical motor, which has been designed with a special view to the production of a machine at once compact and well constructed, and having a high percentage of efficiency

The field magnets constitute the main portion of the machine. The accompanying drawings are made on a scale of half an inch to the inch, or exactly half size, the full size and dimensions being marked on the dimension lines.

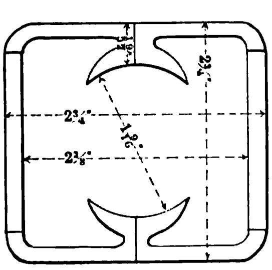

FIGURE 1.

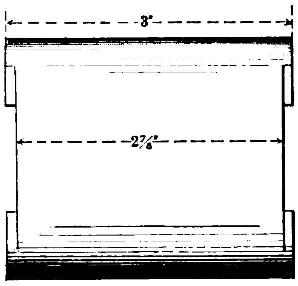

FIGURE 2.

Figure 1 is an end view of the two castings of the field magnets, placed side by side in their proper places, and figure 2 is a side elevation of the same. Figure 3 is an end, and figure 4 a side view of the armature. It is essential that these should be cast from the very best of iron, and thoroughly annealed, so that the character of the metal may approximate as nearly as possible that of wrought iron. Many failures and much loss of electrical energy have resulted from inattention to this important point.

The armature is of the well-known Siemens or **H** form, which is undoubtedly the best ever devised for small motors. Its efficiency is high, while it may be constructed with facility by an amateur of ordinary mechanical skill.

It is preferable to substitute gun metal for brass in the bearings and other non-magnetic portions of the machine, as the use of this material will well repay its slightly increased cost and small amount of additional labor required. The unsatisfactory results which have been attained by amateur constructors of dynamos and motors are largely due to the use of inferior metal.

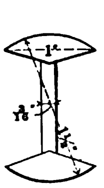

FIGURE 3.

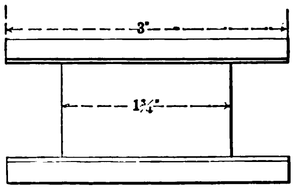

FIGURE 4.

Figure 5 is a front view of the gun metal bearing through which passes the armature shaft or spindle. This is made in two different sizes, which are marked full-size on the drawing. Side views of the same are given in figures 6 and 7. These bearings must be accurately fitted, and care must be taken that they are well trued up, as they must fit square on to the field magnets, as shown in figures 10 and 11. It is not essential that the exact design and shape shown in the drawings should be followed, as this may be varied to suit the fancy of the constructor, providing of course that the mechanical principles shown in the drawing are adhered to and faithfully carried out. Figures 8 and 9 show the gun metal caps which screw on to ends of the armature, into which are screwed the spindles by which the armature is carried. These spindles can be

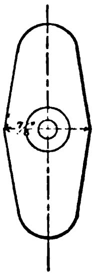

FIGURE 5.

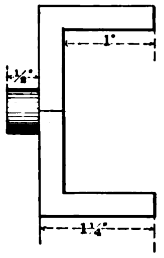

FIGURE 6.

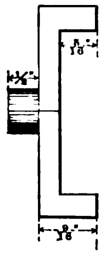

FIGURE 7.

soldered in their places, or secured by pins passing directly through them, to prevent them from unscrewing.

The remark above made, in respect to the precaution of getting everything true, must be borne in mind in every-

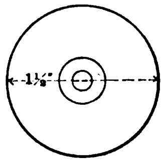

FIG. 8.

FIG. 9.

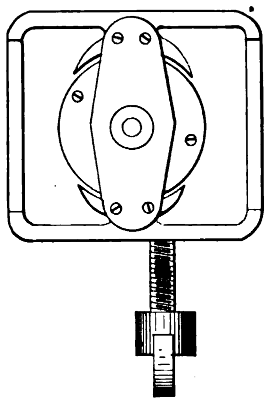

FIGURE 11.

thing relating to the construction of motors and dynamo-electric machines. Such machinery will not allow of any slovenly or slip-shod fitting.

Figure 10 is a cross-section taken through the centre of the armature but not precisely in the centre line of the field magnets, the object being to show in the section the

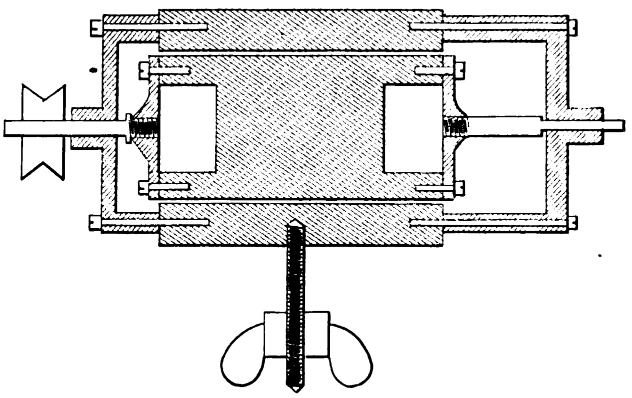

FIGURE 10.

screws by which the bearings are secured to the field magnets. Figure 11 is an end view, in which it will be noticed that the bearings shown in the previous figures 5, 6 and 7 also serve the purpose of binding the outer iron work or field magnets together. A bolt and thumb-nut is shown for securing the machine to a bench or other suitable bed, but if preferred it may be mounted on a polished wooden base.

(*To be continued.*)

1. *English Mechanic* (Abridged).

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ELECTRO-CHEMICAL EQUIVALENTS.

BY GEORGE B. PRESCOTT, JR.

According to a recent determination by that careful investigator, Lord Rayleigh (B. A. Rep., 1882), the rate at which silver is deposited under the electrolytic action of a current is 1.118 milligrammes per coulomb of electricity, or, in C. G. S. measure, 1.118×10^{-2}. This value has been generally considered to be more reliable than the old figures of the text-books,[1] and, since later independent experiments by Kohlrausch and Mascart have led to values almost identical, it is now commonly accepted, with confidence that it is at least more nearly correct than any of the figures previously taken.

On the basis of Rayleigh's value for silver I have calculated the electro-chemical equivalents of the other elements usually so tabulated, adding to them potassium and magnesium, metals now reduced by electrolysis.

Although in tables of this nature it has heretofore been customary to employ round numbers to specify atomic weights, I have thought it desirable to base the calculations on the latest accepted atomic weights of the elements as given by Roscoe. In addition to milligrammes per coulomb I have calculated the coulombs per gramme and grammes per ampère hour, all of which figures are given in the following table, including, for the convenience of users, logarithms of the last two named values.

TABLE OF ELECTRO-CHEMICAL EQUIVALENTS, ETC.,

Calculated on the basis of Lord Rayleigh's recent determination of the electro-chemical equivalent of Silver, and the corrected atomic weights of the elements as given by Roscoe.

Elements.	Valency.	Atomic Weight.	Chemical Equivalent. e	Electro-Chemical Equivalent (Milligrammes per Coulomb.) z	Coulombs per Gramme. q	Grammes per Ampère Hour. w	Log. q	Log. w
Electro-Positive.								
Hydrogen	H^{I}	1.	1.	.010384	96293.00	0.08738	4.9836358	$\bar{1}$.5727090
Potassium	K^{I}	39.04	39.04	.40539	2467.50	1.45950	3.3922572	0.1642041
Sodium	Na_{I}	22.99	22.99	.23873	4188.90	0.85942	3.6221000	$\bar{1}$.9342055
Aluminum	Al^{III}	27.3	9.1	.09449	1058.30	3.40180	3.0245939	0.5317086
Magnesium	Mg^{II}	23.94	11.97	.12430	804.03	4.47470	2.9055411	0.6507614
Gold	Au^{III}	196.2	65.4	.67911	1473.50	2.44480	3.1683501	0.3882433
Silver	Ag^{I}	107.66	107.66	1.11800	894.41	4.02500	2.9515366	0.6047659
Copper (Cupric)	Cu^{II}	63.	31.5	.32709	3058.60	1.17700	3.4855227	0.0707765
" (Cuprous)	Cu^{I}	63.	63.	.65419	1525.30	2.35500	3.1833553	0.3719909
Mercury (Mercuric)	Hg^{I}	199.8	99.9	1.03740	963.99	3.73450	2.9840725	0.5722325
" (Mercurous)	Hg^{I}	199.8	199.8	2.07470	481.99	7.46900	2.6830380	0.8732625
Tin (Stannic)	Su^{IV}	117.8	29.45	.30581	3270.00	1.10090	3.5145478	0.0417479
" (Stannous)	Su^{II}	117.8	58.9	.61162	1635.00	2.20180	3.2135178	0.3427779
Iron (Ferric)	Fe^{IV}	55.9	18.64*	.19356	5166.4	.69681	3.7131894	$\bar{1}$.8431131
" (Ferrous)	Fe^{II}	55.9	27.95	.29035	3445.50	1.04480	3.5372523	0.0190332
Nickel	Ni^{II}	58.6	29.3	.30425	3286.80	1.09530	3.5167738	0.0395331
Zinc	Zu^{II}	64.9	32.45	.33696	2967.10	1.21330	3.4723322	0.0839682
Lead	Pb^{II}	206.4	103.2	1.07160	933.26	3.85780	2.9700027	0.5863397
Electro Negative.								
Oxygen	O^{II}	15.96	7.98	.08286				
Chlorine	Cl^{I}	35.37	35.37	.36728				
Iodine	I^{I}	126.53	126.53	1.31390				
Bromine	Br^{I}	79.75	79.75	.82812				
Nitrogen	N^{III}	14.01	4.67	.04849				

* Becquerel's extension of Faraday's law showed that the electro-chemical equivalent of an element is proportional to its chemical equivalent. The latter is equal to its combining weight, and not to atomic weight÷valency as defined by Thompson, Hospitalier and others who have copied their tables. For example, the ferric salt is an exception to Thompson's rule, as are sesqui salts in general

Weston Laboratory, Newark, Dec. 13, 1884.

1. Sprague, 1.104; Thompson, 1.134, etc.

THE GROWTH OF TECHNICAL TERMS.

We are moved to refer once more to this subject by the rapid augmentation of words which, because oftentimes backed more by caprice than authority, must inevitably lead to great confusion. Here are a few of these terms of more recent genesis:

The erg.	The watt.	The metric horse power.
The volt.	The henry.	The kilowatt.
The franklin.	The microfarad	The megohm.
The dyne.	The ampère.	The ohm.
The force de cheval.	The centimetre-gramme-second.	

Some of these terms have, by general consent, taken their places as permanent additions to the language of technical science; others are more in the line of test or suggestion. We see in all of this the struggle of a new branch of practical science for definite expression, and as such we welcome these new terms, but "on trial only." Some of them are useless, others barbarous—all of them confusing until brought to the best authoritative definition. The great trouble is that so many of these terms are sprung upon the technical world by self-appointed authorities, who, because their pet words chance to be made use of occasionally by third parties, at once jump at the conclusion that a valuable addition has been made to the language. For instance, it is proposed to call the fellow who runs the electric motor a "motoneer." [Note to the printer: Don't set this up "mutineer."] The next thing, we will have "gasetteer" for the man that runs the gas engine, "keeleteer" for the manipulator of the Keely motor, and "muleteer" for the engineer of the canal boat. Since we are in the midst of a rage for new words, it behooves all good citizens to invent one and then take to tall timber. The fool-killer is on his rounds.—*Iron Trade Review.*

THE MYSTERIES AND MISERIES OF SCIENCE.

An eminent Italian scientist who has been engaged in a new determination of the ohm by absolute measurement, gives in his official report the following harrowing details of the difficulties he has labored under. Some of the discordant results attained by various observers are possibly traceable to causes of this kind hitherto suppressed.

"An other circumstance for me very distressing, is come to influence the rigor of long series of experiences. My laboratory finds itself on the ground floor, in a vast room, very stable and situated at the north; but alongside finds itself the laboratory of chemistry, so that I have the misfortune to have for neighbor, the Prof. Ugo Schiff, who (thing unbelieveable) himself is amused to carry from right and from left long pieces of iron, though he me had promised formally of it to refrain himself.

Now that I have inflicted to M. Schiff, the blame that he merits, in him denouncing publicly, I me propose to explain briefly the manner of which one makes the observations."

MEASUREMENT OF CURRENT STRENGTH WITH A SHUNTED GALVANOMETER.

BY CARL HERING.

The method of measuring currents by means of a shunted mirror galvanometer, or the "shunt method" as it is commonly called, consists essentially of a large, heavy copper wire, having near its ends 2 wires leading to a sensitive mirror galvanometer in series with an adjustable resistance, as shown in figure 1.

The different proportions of the parts are so chosen, that by varying the adjustable resistance any desired strength of currents can be measured with almost the same percentage of accuracy. The shunted galvanometer is calibrated by means of a voltameter, for any convenient steady current, and for a given resistance in circuit with the galvanometer.

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The resistance of the galvanometer *in series with the shunt* is measured, and from it and the constant obtained by calibration, the various constants for different resistances can be accurately calculated, as will be described later. It is not necessary to determine the proportion of the galvanometer resistance to the shunt resistance, as is commonly supposed, and therefore the multiplication of errors and the error of measuring the small resistance of the shunt, are entirely eliminated, as will be seen below.

The 2 dimensions of the shunt—diameter and length—are calculated from the largest and smallest currents to be measured. The diameter is calculated so that the largest current used will not heat it to such an extent as to cause an error greater than the allowable error, say $\frac{1}{10}$ of 1 per cent. It is preferable, instead of using 1 wire, to use a number of smaller ones parallel, with their ends firmly fastened together with silver solder. The length of the shunt wire is determined by the smallest current and should be such that this current gives a deflection of the needle which can be read to the limit of error allowable, while the adjustable resistance is made zero. For instance,

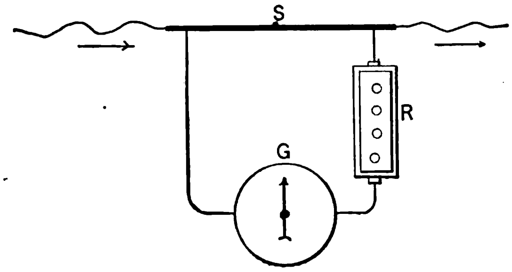

FIGURE 1.

if the allowable error is $\frac{1}{10}$ of 1 per cent., and the scale is in millimeters, the deflection should be at least 10 cm., as any good observer can estimate to $\frac{1}{10}$ of a mm. through a good telescope.

It is very necessary to have a secure contact where the galvanometer wires are fastened to the shunt. They should always be soldered and preferably with silver solder. The shunt wire must be so bent that the large currents in it will neutralize each other as much as possible, so as not to influence the galvanometer needle. It is well to place the shunt so that its plane passes through the plane of the needle. The influence of the current in it upon the needle can then be entirely neglected. Care should be taken that the shunt is well insulated from the ground, and that the effect of the current in the leads on the galvanometer is eliminated.

The galvanometer should be of comparatively low resistance, so that the adjustable resistance forms a large part of the total resistance of the galvanometer circuit, thus allowing for a large range of currents. It is, of course, very desirable to have the needle well dampened, so that the resistance will not have time to heat enough to cause error. The most convenient and accurate method of reading is with telescope and scale, as the cross hairs in the telescope admit of very accurate reading, and it is independent of the lamp used in the ordinary Thomson method. The distance from the scale to the mirror should be as great as possible so as to admit of using a large reading without causing an error. It may easily be calculated what the maximum deflection can be for a given distance of scale, so that the error of proportionality between current strength in galvanometer and reading of scale, is inside of a certain limit. Limiting the error to less than $\frac{1}{10}$ of 1 per cent., the deflection should not be more than 10 to 15 c m. for a distance of scale of about 2 meters. This makes the maximum deflection of needle about $1\frac{1}{2}$ degrees.

To eliminate the effect of a change of the earth's magnetism or any other magnetic change, it is necessary to put a commutator into the galvanometer circuit, and to take readings to the right and left, taking half their difference. This commutator and the leading wires should be carefully insulated from the ground.

For the adjustable resistance, an ordinary plug resistance box can be used. It is not necessary that the absolute resistances be known, as all the resistances of that circuit may be measured in terms of those in the box. It is necessary, however, to know their relative values. If this resistance is of copper, the effect of temperature of the room is entirely eliminated, because the resistance of the shunt and galvanometer circuit are changed in the same proportion; but if it is of german silver, the relative resistances of the shunt and galvanometer circuit will change for different temperatures of the room, necessitating a correction of the constant, as will be shown later.

The calibration is made by means of a voltameter in the main circuit, as shown in the sketch (figure 2) in which G is the galvanometer, R the resistance, C the commutator, S the shunt, V the voltameter and B the battery.

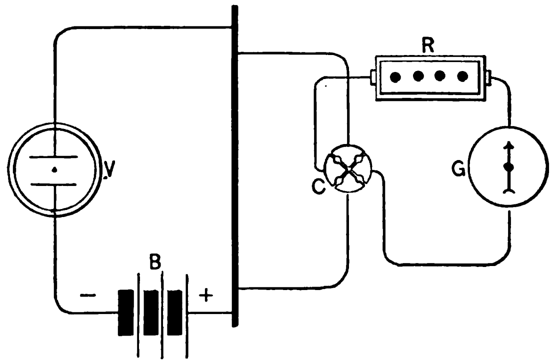

FIGURE 2.

The copper voltameter is generally used on account of its simplicity and the nature of the deposit, which, if proper precautions are taken, will always be a smooth, hard and firm one. The solution of copper sulphate should be as pure as possible, and about 3 parts saturated solution and 2 parts distilled water. It should be well stirred before using it. In using a fresh solution it is better to pass the current through it for 10 to 15 minutes before the calibration, as the first deposit is often imperfect. The anode should be of moderately pure copper, best obtained by electrolysis. The negative plate should be of platinum and not of copper; it should be accurately weighed before each calibration, as it is found that the weight decreases slightly by dissolving the copper deposits of the previous calibration or some other cause. The current strength used to obtain a good deposit is about .15 to .2 ampères for each square inch of single surface, or .3 to .4 ampères for double surface, when 2 copper anodes are used, 1 on each side of the platinum plate. The plate should be well washed with distilled water immediately after the calibration, and dried between filter paper, not over the gas jet.[1] The battery should be as constant as possible and should be put on closed circuit for a while before the calibration. Secondary batteries of low resistance are decidedly preferable. In case the batteries are not constant it is well to put into the main circuit an adjustable low resistance to keep the current constant.

The determinations of the electro-chemical equivalent by Kohlrausch and Rayleigh agree so very closely that their allowable error is entirely within the limits of ordinary practice.

1. It is better to have the platinum or negative plate larger than the copper anode, as it helps to diminish the tendency of the formation of a "beard" on the edges of the platinum plate. From ⅛ inch to 1 inch or even more, on all 3 sides has been found to answer very well, for a plate of 10-20 square inches.

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Taking 19.686 mg. of copper per minute and per ampère (Kohlrausch, 1884), and letting

W = weight of copper deposited in milligrams,
D = average deflection during the calibration,
T = time in minutes,
C = current strength in ampères,
K = the constant required, that is, the number of ampères per unit of scale.

Then
$$C = \frac{W}{T \times 19.686}$$
and
$$K = \frac{C}{D} = \frac{W}{D\,T\,19.686}$$

This is the value for the resistance R in the resistance box used during the calibration. The constants for different resistances are calculated from the following formula:

$$K_1 = K\frac{R_1 + G + S}{R + G + S},$$

in which R_1 = the other resistance and $G + S$ the resistance of shunt and galvanometer *in series*. G includes the resistance of leads and commutator. From this equation it is easily seen how very little the resistance of the shunt affects the calculated constants; being in both numerator and denominator of the fraction its value is generally beyond the third decimal place, so that it almost disappears in the equation.

To prove this formula, let

C = the current strength in main circuit,
a and b = the currents in shunt and galvanometer respectively, for a resistance R,
a_1 and b_1 = same for R_1,
The other letters are the same as above.

As the resistance of the shunt is such a very small part of the whole circuit, a change in the resistance of a circuit parallel to the shunt does not change the current appreciably, therefore

$$C = a + b = a_1 + b_1.$$

For the same current

$$\frac{K}{K_1} = \frac{b_1}{b},$$

and
$$\frac{b}{a} = \frac{S}{G + R} \text{ and } \frac{b_1}{a_1} = \frac{S}{G + R_1}.$$

Combining these equations and eliminating the values of a, b, a_1, b_1 and c gives

$$\frac{K}{K^1} = \frac{R + G + S}{R_1 + G + S},$$

or
$$K_1 = K\frac{R_1 + G + S}{R + G + S}.$$

The easiest way to measure the resistance of G + S in terms of the resistances of the box, is to take the deflections for 2 resistances R and R_1 alternately and for the same current. These deflections will then be inversely as the constants, the current being the same. Substituting in the above equation the deflections D and D_1 gives

$$\frac{K}{K_1} = \frac{D_1}{D} = \frac{R + G + S}{R_1 + G + S},$$

or
$$G + S = \frac{D\,R - D_1 R_1}{D_1 - D}.$$

This will be the same for any 2 resistances, but the best conditions are evidently when R and R_1 are near to the value of G.

When the adjustable resistance is of copper there is no temperature reduction necessary, as explained above. For german silver, the correction is as follows, for centigrade degrees:

$$\frac{k}{K} = 1 + \frac{r}{R + G + S}\,.00331\,(T - t).$$

Large letters represent the values for the high temperature and small ones for the low temperature.[2]

To demonstrate this, let

m = temperature coefficient for copper,
n = temperature coefficient for german silver,
Other letters the same as above, capitals for high and small for low temperatures.

$$C = a + b = A + B;$$

$$\frac{a}{b} = \frac{r + g}{s} \text{ and } \frac{A}{B} = \frac{R + G}{S};$$

$$\frac{k}{K} = \frac{B}{b}.$$

Eliminating A and a from first two equations, gives

$$b = \frac{C\,S}{r + g + s} \text{ and } B = \frac{C\,S}{R + G + S}.$$

Combining with third equation

$$\frac{k}{K} = \frac{S\,(r + g + s)}{s\,(R + G + S)}.$$

Substituting for $S = s\,[1 + m\,(T - t)]$
and for
$$R + G + S = r\,[1 + (T - t)\,n] + (g + s)\,[1 + (T - t)\,m]$$
and dividing, gives the desired formula, in which the values of m = .0037 and n = .00039 are substituted. This correction, though small, is very necessary for accurate measurements.

This method is essentially the same that was used at the tests of the Munich, Vienna and Philadelphia electrical exhibitions, where it proved to be an excellent one, especially on account of its convenience and sensitiveness.

In the tests made at the Philadelphia exhibition, 2 shunts were used with the same galvanometer; the first for currents from a fraction of an ampère to 50, and the second from 50 to 300. The first was made of 2 parallel No. 0 naked copper wires, each 4 meters long. The second had 10 parallel wires of the same diameter and $0^{m}381$ long, securely fastened at their ends in a brass casting into which the galvanometer wires were soldered. Neither of the shunts heated perceptibly with the currents for which they were used.

The resistances were an Elliott box of german silver from 1 to 50 ohms. The resistances of the galvanometer and shunt were measured by the method above mentioned, for many different resistances and were found to agree very well, giving as an average about 1.4 ohms.

The calibrations lasted from 20 to 40 minutes, reading every half minute. They were repeated for various resistances, current strengths and temperatures, and when reduced to like conditions agreed very well, notwithstanding the unfavorable circumstances at the test house.

The method can be made direct reading by making the adjustable resistance of copper, so that the constants are reduced each time by ½ or some other amount, and by dividing the scale into ampères for the resistance zero in the resistance box.

2. The calculations are very much simplified by calculating the constants for two extreme temperatures and interpolating for intermediate temperatures, taking the correction proportional to the number of degrees. This is accurate enough for almost all purposes.

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STORAGE BATTERIES.[1]

The importance and desirability of an efficient and economical storage battery have been very widely recognized, but it is at the present time pretty generally felt that no existing form of storage battery is perfect, and that they are on the whole extravagant and wasteful to an extent sufficient to more than compensate for their undeniable convenience. It is perfectly certain that their employment has not become at all general, and that they have failed to realize the somewhat sanguine hopes of their early promoters.

It seems worth while to examine into the causes of this partial failure, and to inquire how far the evil opinion held by many practical men concerning our present method of storing electrical energy is justifiable.

One of the main objections is that storage involves a loss of some 50 per cent. of the whole. Now all methods of storing and transmitting energy involves some loss. To say that any particular method involves a loss of 50 or even 90 per cent. is not to condemn it utterly. There are many cases when the convenience of storage outweighs the evil of waste altogether; three principal ones may be specified.

(1.) When the power of the source would be otherwise so completely wasted that every fraction of it stored is clear gain. This is the case of much terrestrial water power. The energy of the tides or of Niagara is enormous, and wholly wasted so far as human activity is concerned; if 50 or even 10 per cent. could be stored in such a way as to be conveniently available, it would be of considerable value, and any arrangement capable of effecting this storage could only with injustice be stigmatized as wasteful. The solar energy of the carboniferous epoch has most of it been wasted; but a small fraction—probably not a millionth per cent.—has been saved and stored in the coal-measures. It is possible to abuse the coal for not having stored more, but we find it a useful modicum nevertheless.

(2.) A second case when the advantage of storage overbalances the loss is when regularity and continuity of supply is needed, and when the source is irregular and fitful. Wind and wave power illustrate this kind of source; it is manifest that wind power has not been so largely used as it would have been, had it been steady and dependable. A practicable method of storing up its energy and giving it out as wanted would gradually cause it to be very largely employed. This case is also illustrated faintly by a gas-engine or jerky motor of any kind, and the regularity and dependableness of a storage cistern may very well make it desirable to put up with some waste provided it be not excessive. Mechanical devices for approximating to regularity, such as the use of slack driving belts, undoubtedly give rise to a waste of power, and so does any form of regulator. But in the utilization of artificial forms of power like this, questions of economy become almost pre-eminent; and wastefulness is here a most serious objection, and, it may be, prohibitive defect. At the same time, if the engine is liable to stop, or if it is not always working, some mode of storing energy may be absolutely necessary, whether wasteful or not.

(3.) Another case, and to some extent the converse of the last, is when the available source is weak, though continuous, while the power is only needed for a short time, but during that time is required to be great. This is exemplified in the operation of pile-driving, where energy is stored in the slowly-raised weight to be suddenly expended on the head of the pile, also in the operation of drawing a bow; or again when a small waterfall or steam-engine, running continuously, is to be utilized for lighting during 5 or 6 hours each day; the obviously right plan in such circumstances as these is to store the energy during the hours it is not wanted, and thus virtually to double or treble the power of the source while it is actually in use.

1. O. J. L. in *Nature*.

Unless, however, the loss occasioned by storage were reasonably small, there would be but small gain in attempting the process in this third case.

It is plainly advantageous to devise a method of storing that shall give out the greater part of what is put in; but we see by these examples that a reasonable loss may be more than compensated by convenience, regularity, availability, and dependableness. Again, when energy has to be transmitted over great distances, it is in practice difficult or impossible to make the expenditure of energy at one end depend upon and be regulated by its consumption at the other; and so, without some system of storage, great waste will ensue during intervals of small consumption. Looking to the immense development which the transmission of energy may be expected to undergo in the course of the next few decades, a convenient and manageable method of receiving large quantities of transmitted energy, and of holding it in readiness until wanted, must be of prime importance.

It was in view of such applications as these that the invention of the storage battery by Faure was hailed with enthusiasm by the highest scientific authority in Great Britain; while the public, jumping to the conclusion that a thing for which so many uses could be instantly found must needs be a profitable investment, hastened to provide money, not for commencing careful experiments and perfecting the arrangement, which would have been wise, but for manufacturing tons of apparatus in its first crude, immature, and untried form. Some day it may perhaps be recognized that because it can be shown that a thing will be extremely useful when perfect it does not follow that it has already attained that perfection, that indeed probabilities based on historical developments are enormously against such abnormal and instantaneous maturity, and that the careful nursing and rearing necessary to healthy maturity are better given in the seclusion of laboratory and study than in the excited and heated atmosphere of the Stock Exchange. It is doubtless recognized already that all preliminary operations are better conducted on a scale smaller than the wholesale manufacturing one. In developing a new industry there are scientific difficulties to be overcome, and there are manufacturing difficulties. By scientific difficulties we mean such as the determination of weak points, the best ways of strengthening them, and generally the discovery of theoretically the best modes of effecting the object in view: manufacturing difficulties begin with questions of expediency and economy—how most cheaply and satisfactorily to carry out the indications of theory, to obtain this or that material—and include the organization of a system of manufacture, of division of labor, of machine tools, which shall enable the work to be done with economy, security and despatch. Over-haste in the preliminary stages causes both these sets of difficulties to be tackled together, and so throws a grievous burden on both adviser and manager. All these untoward conditions have storage batteries experienced; and to say they have not fulfilled the hopes of their early promoters is no more than to say that those hopes were untimely and unreasonable. The period of maturity has been undoubtedly delayed by injudicious treatment, but its ultimate attainment seems to us inevitable; and it is at present a matter of opinion how nearly it has already been reached: certainly great steps towards it have been made. Let us inquire what some of the difficulties encountered have been, and it will be seen that, formidable as some of them are, they belong essentially to an infantile stage, and are not suggestive of constitutional debility.

The first form of manufacture consisted in rolling up sheets of lead and composition, with trousering to keep them separate. The difficulties found were that the coatings would not adhere, but became detached in large flakes; that the trousering got corroded through and permitted short circuiting: and that free circulation of fluid being impossible, the acid became exhausted in some

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places and concentrated at others, and thus every sort of irregularity began. Now regularity or uniformity is of the most vital and fundamental importance in any form of battery. If any part of a plate is inactive, that part is better away; if any plate in a cell is inactive, it is better away; and if any cells of a battery are inactive, they are infinitely better away. The rolling or coiling up of the sheets being found awkward in practice and liable to detach the coatings, flat plates came to be used, then perforated plates, and then cast grids; these last having such large hole space, that they held enough composition, and held it securely enough, to enable the trousering or intermediate porous material to be dispensed with. This was an evident step in advance: free circulation of the liquid became possible, and could be assisted by stirring; there was nothing to corrode except the plates themselves, and the composition, being in the cells or holes of the grid, might be reasonably expected to adhere. So far expectation was not altogether belied. The adhesion was not perfect, it was true, and pieces of composition sometimes fell out of the holes, especially if too powerful currents were passed through the cell, but still it was much better than it had been; and if the plates were well filled, properly formed, and fairly treated, the composition adhered extremely well and securely. The circulation of the liquid was not automatically perfect either, but mechanical agitation could be readily applied; without it the acid near the bottom of the cells tended to become more concentrated than that near the top, not by reason of gravitation undoing diffusion, which is impossible, but because during each charging fresh acid is formed, and in great part falls to the bottom in visible streams. Another great advantage was that some amount of inspection of the plates became possible, and experience as to the actual behavior and appearance of the plates, began to be accumulated. And painfully varied that experience was. Every variety of extraordinary behavior which could be suggested as probable, and a good many which no one could possibly have imagined beforehand, made their appearance. The hundreds of tons of batteries made at this period doubtless enabled these unpleasant experiences to be more rapidly acquired than would have been done on a small scale, but it was a costly series of experiments. However, the experiments were made, the public involuntarily assisted in the acquisition of experience, and, caring less for knowledge than for marketable commodities, they expressed dissatisfaction at the result. Many of these incipient difficulties are now overcome by the manufacturers, but the great dislike of the public to involuntary experiments, and the shock which their confidence underwent on being unexpectedly called upon to participate in research, have not yet altogether abated.

The main difficulty now experienced was how to keep the plates from touching. They might be put in wooden frames, or elastic bands might be stretched round each of them, and if they would only keep flat it was impossible they should touch unless the composition should drop out of the holes. Sometimes the composition did drop out of a hole, and bridge across the interval between 2 plates, but the more common and more fatal experience was that the plates would not keep straight. In a few months the positives were found to swell, and as they swelled to buckle—to buckle and twist into every variety of form, so that elastic bands, wooden frames, and every other contrivance failed altogether to prevent short-circuiting. The cause of the buckling is of course irregular and one-sided swelling, and the cause of the swelling is apparently the gradual peroxidation and sulphating of the material of the bars of the lead grid, which occupy less room as metallic lead than as oxide or salt. As the bars swell, they press on the inclosed composition, occasionally driving it out, but more frequently, and with properly made and treated plates universally, distending themselves and stretching the whole medial portion of the plate. The edge or frame of the grid is stronger than the middle bars, and is not so easily stretched; in a good and uniformly worked plate it does stretch, and an old positive plate is some quarter of an inch bigger every way than a new one, but if one face of the plate is a trifle more active than the other, it is very plain that the most active side will tend to become convex: and buckling once begun very easily goes on. To cure it 2 opposite plans have been tried: 1 is to leave the plates as free and unconstrained as possible, hanging free it may be from 2 points, thin, and with crinkled or crimped margins to allow for expansion; the other is to make them thick and strong, with plentiful ribs for stiffness, and besides to clamp them up one to another as tightly as may be, and thus in mechanical ways to resist buckling and distortion. I do not know that any one could say for certain beforehand which of these 2 plans would be likely to answer best, but practice is beginning to reply in favor of the latter, and well braced plates of fair thickness show no unmanageable tendency to buckle. It must be remembered that no material can buckle with a force greater than that necessary to restore it to flatness, and this force in the case of lead is very moderate. Hence it may be fairly hoped to overcome and restrain all exuberances by suitable clamps and guides arranged so as to permit flat and even growth, but to check all lateral warpings and excrescences.

Uniformity of action is still essential, especially if all the plates in a cell are clamped together. Plates mechanically treated alike ought to be electrically so treated also, and it is impossible to keep a set of plates working satisfactorily together unless the contact of each is thoroughly and equally good, so that each may receive its fair share of current. Defects of contact have been a fruitful source of break-down and irregularity. Clamps and screws of every variety have been tried, but the insidious corroding action of nascent oxygen exerted through the film of acid which by spray and creeping forms and concentrates on the lugs—this corroding action crawls between the clamped surfaces, gradually destroys all perfect contact, and sometimes produces almost complete insulation. Contacts on the negative plates give but little trouble; contacts on the positives have taxed a great amount of patience. Lead contacts "burned," *i. e.* melted, not soldered on, are evidently less liable to corrosion than brass or copper fittings, or than any form of clamp, but they are apt to be somewhat clumsy if of sufficient conductivity, and moreover they are awkward to undo again, and somewhat troublesome to do. However they have proved themselves so decidedly the best that now no other contacts will be used, and their re-introduction has been followed by a marked improvement in the behavior of the cells. So long as contact with one plate was better than with another, a thing quite possible to happen without any difference being perceptible to the eye, so long was it possible for 1 or 2 plates to remain almost wholly inactive while another 1 or 2 received far more than their share of current, and became distended, warped, overcharged, and ultimately crumbled away. If 1 or 2 plates in a cell are black, and giving off torrents of gas, while the rest are brown and idle-looking, it is pretty fair evidence of irregular and insufficient contact, or else of some great discrepancy in the age or make of the plates. This point also is one that was not attended to in the early stages of manufacture; plates were made for stock, and cells were made up with plates of all ages selected at random from the store. Directly uniformity is perceived to be essential, this is recognized as obviously bad. Plates intended to work together should be of the same age and make, and inasmuch as keeping does not improve them, the best plan is not to make for stock, but to keep material ready, and then quickly make up as wanted. Plates in work deteriorate slowly, but they are wearing out in the fulfilment of their proper function; plates in idleness deteriorate as quickly, and they are rusting out in fulfillment of no function at all.

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Worn-out plates, however, are by no means valueless. Lead material has a well recognized price, and if attention were given to the subject, it is probable that decrepit and useless plates might be made to yield a very large percentage, if not the whole, of their original lead. For it must be remembered that plates deteriorate not by waste but by accretion: an old plate contains as much lead as a new one, but it contains it with the addition of oxygen and sulphion; no longer a tenacious coherent frame, but a crumbling mass of incoherent powder.

The age of plates is a point of vital interest, though but little is known as to the possibilities in this direction at present. A year may be regarded as a fair average age at the present time; but this is a low rather than a high estimate. Thick plates are found to last far longer than thin, which is only natural when it is remembered that the wearing out is due to corrosion, that corrosion proceeds mainly from the surface inwards, and that the internal portions of a thick plate are to a great extent protected by the mass of superincumbent material. If it can be shown, as we understand it can, (1) that the cost of materials is far more than the cost of manufacture; (2) that the worn-out material has a market value not incomparably less than the original; and (3) that the frequency with which plates have to be renewed is not such as to cause much inconvenience; then we hold that the first stage of the durability difficulty has been overcome. Much more may be hoped for in this direction as experience increases, and it is not extravagant to hope that a well-ribbed, properly-clamped, and fairly-treated thick plate may last as long as five years before it becomes disintegrated.

It is evident, however, that in a region where pure experiment is pre-eminent, and where the units of time are months and years, instead of hours and days, the accumulation of experience is a slow and tedious process. It is no use making statements involving periods of five years when no one has had the present improved form in use for so much as 6 months. Nevertheless it is possible to see that the present cells are better than their predecessors; and as their predecessors have lasted in good condition for a year and more it is not presumptuous to indulge in well-founded hopes. Many of the difficulties connected with the early forms of battery were aggravated by Utopian notions concerning internal resistance and compactness. The internal resistance of a cell was so beautifully small, that the manufacturers were tempted to diminish it still further by putting the plates far too close together. An eighth or tenth of an inch interval is well enough if the plates had been hard rigid slabs of perfect flatness; but it was madness to pack flexible lead plates full of composition certain to swell and liable to drop out so near together as this. Security and dependableness were sacrificed to a natural desire for sudden and Utopian perfection. We may hope that these lessons have been profited by, and that the manufacturers perceive that confidence and security are the first conditions of success, and that minutiæ as to the number of noughts before the significant figures in the specification of resistance begin, though those also are of importance in their turn, are yet of quite secondary consideration. Moreover, this packing of the plates so closely did not really do much to secure the result desired; the greater part of the resistance of half run-down cells is not in the liquid between the plates, but in the surface or scum separating each plate, and especially each negative plate, from the liquid, and hence putting the plates a safe distance, say a quarter or one-third of an inch apart, exerts an effect on the total resistance which is certainly far more than compensated by the ready opportunity thus afforded for access by both sight and touch. The old opaque boxes chock full of plates, with slight india-rubber bands between them, were started and left to Providence. No one could see what went on, nor could one readily get at anything to rectify what was wrong. In the present glass boxes properly arranged on accessible shelves with only plugs or studs between the plates, clear vision through the cell in any direction is easy, and accidental obstruction not only very seldom occurs but if it does it can without difficulty be seen and removed. But it must be granted that these boxes are less compact than their predecessors, and for some purposes, such as locomotion, compactness is of the first importance. Most true, for some purposes. It is not to be supposed that one type of cell will answer every possible demand. A dynamo to be highly efficient must have a large and massive field magnet, but in some places bulk and weight are fatal objections; and in these places smaller and more compact dynamos may be more suitable: something, however, must be given up to secure the required lightness and compactness, some sort of compromise must be effected. Just so with cells: we can point out what is theoretically the best form, and this form may, for large stationary electric light or power installation, be actually the most suitable; but we may also see that for boats, for tramcars, and for fish torpedoes, some very different and far more compact form may be quite essential.

Efficiency, Durability, Economy, Compactness: it may not be possible to attain all these at once—if it were, there would be small room for discussion—but sometimes one and sometimes another will be the pressing necessity, and manufacturers of storage batteries, like manufacturers of dynamos, must be prepared with forms suited to various needs.

We have spoken mainly of difficulties connected with the positive plates, and have said nothing concerning the negatives. It is not that these are not susceptible of improvement, but their faults have been of a less imperious and obtrusive nature. They are not perfect, but they do fairly well, and there has been little need to worry much about them, until the extraordinary behavior of positives had been taken in hand and checked. The time is coming to attend to these also. They fail not from exuberance, but from inertness. As they grow old, they do not swell, and warp, and burst, and crumble, like the positives, but they grow quietly hoary, and serenely decay. The composition in a worn-out negative consists of white sulphate through and through, but the frame remains intact, and it consequently never falls to pieces, nor does it swell. Impurities in the acid used tell upon a negative plate—nitric acid is fatal. Acid much too weak or very much too strong is also deleterious, and idleness is bad. The difficulties connected with negatives mostly depend on their aggravating property of always requiring a quite opposite treatment to positives. The less a positive is formed and overcharged the better. A negative delights in complete formation and frequent overcharge. In recognition of this it is now customary to form them separately, and to give the negative a thorough dose of hydrogen without commencing the corrosion of the positive by an overdose of oxygen. When the discharge from a cell begins to flag, it is the resisting scum of sulphate that has formed over the negative plate which is responsible for the flagging. The true E. M. F. of a cell is wonderfully constant throughout the whole discharge; but the internal resistance is all the time increasing, at first very slowly, ultimately, towards the end, with a rush. One such run-down cell in the midst of a lot of others therefore obstructs the current terribly. If only a series of cells could with certainty be made to work together uniformly, if a series could behave as well as some of the cells in it, no one would have cause to complain.

Through the whole history of the manufacture, from the very beginning, a few cells here and there have always exhibited astonishing efficiency;—the aim of manufacturers may be said to be to bring all cells up to the level of a few. Much progress in this direction has been made, and it may be very fairly expected that, as uniformity is gradually attained, a series of cells subjected to the same treatment

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may behave in the same manner. Whenever this is certainly accomplished, there will have been reached a high stage of efficiency, beyond which further progress need be only in the improvement of comparably insignificant minutiæ.

The subject of the electrical storage of energy is really one of national importance;—it is comparatively a small matter whether this or that form of storage, or this or that company of manufacturers, succeeds in bringing out the permanent form. It sometimes unfortunately happens that enterprising pioneers only clear the way, and retire just in time for other men to come in and reap the fruits of their labors. So much capital and so much labor have been already expended in the effort to bring storage batteries to perfection, so great progress has been made, and so apparently small are the steps which yet remain to be accomplished, that we may surely fairly hope that some of the original believers in their great, and as it seems to us inevitable, future may yet live to see their faith justified and their patience rewarded, and may even taste some of that so-called "substantial" reward without the hope of which great commercial enterprises would never be undertaken, and modern civilization would have scarcely yet begun.

NEW FORMS OF GALVANIC AND SECONDARY BATTERIES.

European inventors are devoting considerable attention to improvements in batteries, some of the more promising of which may be found described in this article, which has been compiled from different sources.

Among those in which peroxide of lead is used is that of D. Fitzgerald and T. J. Jones. The negative element consists of lead and carbon in contact with peroxide of lead, the peroxide being preferably obtained by the electrolysis of an oxide or salt of lead, or by the conversion of spongy lead into peroxide. When carbon is used as a negative element, it may advantageously be in the form of small fragments surrounding a rod or plate of the same material, the interstices between the fragments being filled with lead peroxide. Lead in a highly porous condition is used for the positive element. It is obtained by a greater or less degree of compression of the metal reduced from its oxides or salts by chemical decomposition or by electrolysis, or by the compression of lead in a state of minute subdivision produced by mechanical means. Dilute sulphuric acid is used as an excitant, which may be improved by holding in solution a small proportion of sulphate or tartrate of ammonia. A new form of carbon battery has been invented by Tommasi and Radiquet, which consists of a rectangular porcelain trough, with a carbon plate at the bottom, surrounded by a paste of peroxide of lead. The other electrode is also formed of a similar carbon plate, upon the upper side of which are placed fragments of platinized retort coke. The two plates are arranged one above the other, separated by a sheet of parchment paper, by which the cell is divided into two compartments. A saturated solution of common salt is then poured in to such a height that the fragments of coke on the upper carbon will be partially immersed. The plate of carbon which does not touch the peroxide of lead is the negative pole. Other saline solutions may be used without materially varying the electromotive force of the cell which is about 0.6 volt.

A battery invented by J. B. Spence and J. E. Chaster, has attained some notoriety because of the claim that it produces a current without expense. This is a copper-zinc battery in which a solution of caustic alkali is used as the exciting fluid, and the depolarizing substance around the copper is oxide of copper. When the spent or partially spent solution is withdrawn from the cells, the zinc therein contained can, it is said, be reclaimed as the commercial oxide of zinc, by passing carbonic acid into the solution which throws down the white carbonate of zinc, leaving carbonate of the alkali in solution. The white carbonate of zinc, when collected, washed, dried and ignited, gives off carbonic acid (which may be used again in another portion of the spent liquid,) leaving oxide of zinc. The solution of the alkaline carbonate obtained by this process may be evaporated, and crystals of alkaline carbonate obtained in the usual commercial form, but it is preferred to boil the alkaline carbonate with caustic lime, so as to convert it into caustic alkali, which when sufficiently evaporated is decanted from the carbonate of lime (formed by the double decomposition in boiling) to be used over again for acting upon a fresh quantity of zinc in the galvanic cell.

Other inventors have devoted their attention to regulating the consumption of zinc and preventing waste of material. The device of Mr. Courtenay is an example of this class. The zinc is coated with layers of asbestos paper previously prepared with an aqueous solution of gum lac, or similar substance, the object being to prevent the wasting of the metal while in the exciting fluid.

Several inventors appear to consider that there is an advantage in making cells with three divisions. Mr. Wenzel of Vienna, patents a voltaic cell consisting of a vessel of impermeable non-conducting material, divided by porous partitions into three compartments. In one of these is placed the positive element of platinum, carbon or the like, immersed in nitric acid of 30° to 40° Beaumé. In another of the compartments is placed the negative electrode, preferably zinc, immersed in a solution of salt about 1 part to 20. The third compartment which is between those containing the electrodes is filled with sulphuric acid of 50° to 70° Beaumé.

A syndicate with a capital of $60,000 has been formed in Paris to exploit the sodium battery invented by M. Jablochkoff. This element was devised for the purpose of obtaining a higher electromotive force than has been the case with any previous invention. Pure sodium in thin plates is used, coupled with compressed carbon, such as is employed in other batteries, or the plates may be placed in a metal capsule, in the midst of broken carbon. Under such conditions and subjected only to the humidity of the air, the battery yields the relatively high electromotive force of four volts, which may be raised to six volts by impregnating the carbon with certain metalloid solutions. This latter fact, however, has no practical value, because the price of such solutions, and the difficulty of using them, make the arrangement quite impracticable. With a couple of sodium and copper, the electromotive force falls to three volts. Such a battery, which may be of value in some cases, is made up of a thin plate of sodium, and a piece of red copper gauze. It will be seen that the force of this battery is considerably in excess of others now in use. On account of the avidity with which sodium decomposes water and absorbs oxygen, it is necessary to shield the battery from exposure when it is not in use, and for this reason it should be kept, except when active, in a bath of naptha, or at all events in a hermetically sealed vessel. M. Jablochkoff asserts that the waste of the sodium, that is to say, its combustion, beyond what is converted into useful energy, is extremely small. One of the objections, which naturally present themselves to this battery, is the great precaution which must be taken in using it, on account of the explosions which occur when sodium is brought into contact with water. With proper precautions, however, such a danger is not great, although more than one serious accident has happened from this cause.

Mr. Sellon has patented an improvement in secondary batteries, which is intended to prevent the leakage of electricity due to the spreading of moisture from various causes, such as through capillary attraction round or over the edges of the plates, or by the condensation of atmospheric moisture, or by the splashing which may occur in charging, and also has reference to modifications in the form of the upper part or edges of the plates in order to arrest the spray which may be given off during formation

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or whilst charging in the ordinary way, and further to give a convenient form for packing in stacks or columns with ready access to the electrolyte, which may at the same time obviate the capillary attraction, or the effect of the splashing or spilling. For instance, with such forms as annular basin or pyramid shaped or other plates, the edges of which can be so treated, the inventor makes grooves, corrugations, or overlappings of suitable form either at or around the extreme edge or conveniently near thereto, or he casts upon, or works up with the plates, projections, or ridges, or bent portions which may serve an equivalent purpose, and into the space or cavity so formed he places any insulating material of a nature suited to arrest or entirely stop the spreading of the moisture which might otherwise form a junction with the moisture on the adjoining plate. A mixture of paraffine with asbestos, or paraffine alone is very suitable for this purpose.

Another improvement in storage batteries is that of S. Kalischer, which consists in the use of iron for the anode, in combination with a solution of suitable salts of lead, the latter being subjected to the process of electrolysis to produce a dense coating of peroxide of lead upon the iron. This coating, on being metallically connected with a cathode of lead in the liquid remaining after the process of electrolysis, will constitute a secondary battery of high electromotive force from which a constant current of long duration can be obtained. According to the principle of the invention, the peroxide of lead is precipitated upon the anode by electrolysis and by means of secondary action respectively, while the iron, which is employed for the anode remains unchanged.

In the secondary battery invented by M. N. Basset of Paris, any oxide is used which is capable of passing from an inferior to a superior state of combination, as well as any of the chlorides, sulphurets, or phosphurets. The most economical element is composed of two plates of retort charcoal or agglomerated carbon, covered with natural peroxide of iron, or granulated colcothar, wrapped in blotting paper, and held together by cords.

H. Woodward has invented a secondary battery made up of lead tubes rammed full of litharge peroxide, acetate or other suitable salt of lead. The tubes having been cut into the lengths required, and charged with the material, are set aside to allow the contents to dry; they are then pierced with a number of holes to permit the acid and the electric current to act upon the enclosed material.

EVOLUTION OF THE ELECTRIC RAILWAY:

ITS COMMERCIAL AND SCIENTIFIC ASPECT.

BY DR. WELLINGTON ADAMS.

(Continued from page 268, Vol III.)

As I have already stated, the most important application of this principle of electric transmission of power is exemplified in the *modern* electric railway. Now, I advisedly use the expression *modern,* because the electric railway, like all other inventions, has a history. It is not a thing of spontaneous development, but of gradual growth. In considering its evolution, we must cursorily glance over the history of the "*electric engine,*" as electro-dynamic machines have heretofore been christened. The earlier "electric engines" or motors belonged to that class or type known as oscillating or reciprocating engines. First to make an oscillating electric motor was a learned monk, strange to say, of Padua—Salvator del Negro, who, in the year 1831, succeeded in operating such a motor. An oscillating motor, however, has many disadvantages, the most important of which is the fact that the moving part (the "armature") at the end of its stroke is at a considerable distance from the attracting electro-magnet (the "field"). This, in electric motors, is a very serious defect, since the electro-magnetic attraction or pull diminishes in intensity very rapidly, varying, as it does, inversely as the square of the distance; so that when the armature begins to approach the field there will be very little, if any, force pulling it. Hence motors built upon this principle proved very little more than pieces of physical apparatus. The first motor for producing rotary motion by electro-magnetism, without a reciprocating action, was invented in 1833 by our now deceased countryman, Prof. Henry, late of the Smithsonian Institution, a description of which may be found in Vol. XX. of Silliman's Journal.

This motor also was but a toy, having the same defect just referred to, as indeed did all motors brought out up to the time of the discovery of the modern "dynamo" principle. Between the time of the advent of Henry's motor and the period of Prof. Page's experiments, of which we shall learn further on, Davenport in our own country, Prof. Jacobi in Russia, Davidson in Scotland, and Mr. Henry Little in England, constructed electric motors of considerable size. Prof. Jacobi propelled a boat by electricity on the Neva, at St. Petersburgh, in 1839; Davenport and Ransom Cook had quite respectable electric motors working in New York in 1840; and Davidson ran an electric locomotive in 1842 on a railroad near the city of Glasgow, Scotland. A little later, Mr. Little operated an electric locomotive in England. Jacobi's motor was of about two h.p.; that of Davidson was a little over one h. p., and propelled a locomotive weighing five tons at the rate of four miles an hour. Excitement upon this subject reigned supreme in New York about 1841, when electro-magnetic engines became a kind of mania, and although commercially worthless, hundreds of them were manufactured to meet the market demand.

The experiments of Jacobi, Davenport and Davidson proved unsatisfactory however, as was predicted by contemporary scientists. This, naturally, caused disappointment and reaction; so that nothing of importance was added to the stock of knowledge concerning the subject until 1845, when Prof. Page, of Salem, Mass., revived and gave to the subject a new impetus by the invention of a new form of electric engine based upon the principle of the axial force of electro-magnetism, which proved to be the most perfect electric motor ever invented up to that time. A few years later, Prof. Page proposed electricity as a motive power for railroads, through the instrumentality of his own electric engine. This engine proved so successful and attracted so much attention that the idea gained favor to such an extent as to induce Congress to appropriate and place at Prof. Page's disposal a sum of money (thirty thousand dollars) adequate to construct and operate an electric locomotive in accordance with his plans. Such a locomotive was built in 1851, and used to propel a train of cars between the cities of Washington and Bladensburg, a distance of five miles. As was natural, such an undertaking created great excitement and discussion in the scientific world, both at home and abroad, more especially because of the governmental sanction and assistance lent the enterprise. The great mathematician and scientist, Dr. Joule, and many others, very properly contended that the system would be too expensive, and that electricity as then generated, could not be used as a motive power with sufficient economy to warrant its adoption on a commercial scale. In fact it was this very discussion which led Dr. Joule to that long and laborious investigation of the mechanical equivalent of heat, which now forms the basis of all our work in thermo-dynamics, and without which we should be groping in the dark.

It was on the 29th day of April, 1851, that Dr. Page made the trial of his locomotive, which ran at the rate of nineteen miles per hour, making the trip of five miles in thirty-nine minutes. The locomotive itself weighed ten and one-half tons, including the batteries, and carried seven passengers. There were many stops and delays on account of the breakage of his battery cells, which were carried up-

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on the locomotive, the jars fulfilling the office of a steam locomotive boiler and furnace, zinc and sulphuric acid in the former case constituting the fuel. The sulphuric acid and zinc were burned or consumed in the production of electricity. This is the principle upon which it was sought to operate all the electric engines thus far referred to. Electricity was here called upon to serve as a prime motor, utilizing the energy stored in sulphuric acid and zinc.

The folly of such an error is manifest, since one pound of zinc costs twenty-five times more, and is not capable of being transformed into as much dynamic force, as one pound of coal. Although Dr. Page's hopes were not realized as far as refers to the commercial aspect of the enterprise, he nevertheless accomplished a great feat, and to the day of his death he contended that the time would surely come when electricity would be economically used as a motive power upon railroads.

Ever since Dr. Page's memorable experiment, thoughtful people have been looking expectantly and anxiously forward to the fulfillment of his prophecy. The time is now ripe for such fulfillment. In fact, it has even now passed from the stage of speculation and become *au fait accompli*, many miles of electric railway, notwithstanding their primeval crudity, now being in successful operation on a commercial scale in different parts of the world.[1]

You ask, I imagine, "What has rendered possible at this day that which was thirty years back demonstrated impracticable; and in what respect does the *modern* electric railway differ from that of the past?"

My answer is: that which has rendered the electric railway commercially feasible, is the discovery by Messrs. Varley, Siemens and Wheatstone, and the subsequent development by many others, of the dynamo-electric machine; and the further discovery or demonstration by MM. Fontaine and Gramme of the reversibility of that machine, which admits of its being transformed into the most efficient form of an electric motor, when a suitable electric current is passed through it. The *difference* between the ancient and the modern electric railway, consists in the fact that whereas the effort was formerly made to use electricity as a *primary* motive power originating from the consumption of zinc and acid, we now use the electric engine or electro-dynamic machine as a *secondary* motor, and the electric current simply as a means of *transmitting* power procured from natural sources or previously generated by any of the known economic methods, if some natural source of power is not at hand. Such a system contemplates the establishment of a central fixed station, where large steam boilers and engines of the most economic type are erected and used to set in operation dynamo-electric machines, which generate powerful currents of electricity. These currents are in turn transmitted through a copper conductor running along the roadway, and, by means of a moving contact, they are taken up into the cars while the latter are in motion, and there passed through an electric engine or electro-dynamic machine, which operates to propel the cars. This idea of the generation by dynamo-electric machines of powerful currents of electricity at stationary points, and the transmission of these electric currents to cars while in motion for the purpose of effecting their propulsion, was first put into execution in 1879, by Dr. Werner Siemens and myself, both of us working independently and mutually ignorant of the other's doings. I constructed a small model, such as was within my limited means, and used the same to demonstrate a lecture on electricity delivered at the time in Colorado Springs, Colorado; about the same time Dr. Siemens exhibited a more extensive model at the Paris Exposition.

In my system the method of applying the power was very different from that adopted by Dr. Siemens; my only object then being to demonstrate the principle of electric transmission of power to a moving car for the purpose of propelling the same. On receiving news of the work of Félix and Chrétien at the sugar plantation at Sermaize, they having resorted to electricity as a source of power for plowing, I was more than ever impressed with the value of the system and of the future which lay before it, and I accordingly began experimenting upon and studying the subject up exhaustively, going thoroughly into every detail.

Although at the time actively engaged in medical practice, and connected with the Medical College in Denver, so great were the allurements, I was induced to give everything up in Colorado and leave there rather precipitately for Washington, in quest of a generic claim upon this fundamental principle. My case being examined, it was, however, found that the same principle had been *proposed* and provisionally patented, although not put in operation or even demonstrated and made public, as far back as 1840, by one Henry Pinkus, a remarkably inventive genius of that period. In 1840, however, the dynamo was unknown, and the electric car motors of Pinkus, which existed only in his imagination, were *supposed* to be operated by galvanic batteries buried in the ground. The principle of the transmission of the current to the car while in motion for the purpose of effecting its propulsion was, however, the same. The inventor even went so far as to anticipate the future use of "mechanical generators, which should be more economical" than the batteries.

Dr. Siemens and myself are consequently antedated as regards the question of first conception of this broad principle, and the underlying feature of the *modern* electric railway becomes public property. My application for a patent upon this fundamental principle is a matter of record in the United States Patent Office. This application was abandoned on discovering the record of the Pinkus patent. Appreciating, however, the rich harvest in store for inventors in this new field who should devise the most practical and economical means of applying this principle, which comprehends an army of important details, I immediately began research into the necessary conditions to a successful solution of this most intricate problem. The results of this investigation, which has cost many thousands of dollars, will, I hope, in your judgment, prove meritorious.

We may, of course, crudely mount upon a car a dynamo-electric machine of our own or another's design, and connect this up with the wheels or axles of the car by means of cog-wheels or belting, and thus effect the propulsion of the car, temporarily for exhibition purposes, regardless of the cost or of practical commercial requirements, as several have done since the first public exhibition of the modern electric railway by Dr. Siemens and myself, the individuals in each instance styling the result as "their electric railway," which as a matter of fact differed, figuratively speaking, but by a bolt or a nut from Siemens's original road.

(*To be continued.*)

FIRST PRINCIPLES FOR YOUNG MECHANICS.[1]

BY COLEMAN SELLERS.

A well grounded knowledge of the great law or principle of conservation of energy should be taught with the multiplication table. It can be so taught if the teachers themselves are certain that there is in the universe only so much energy, and that we cannot make one particle more than already existed. With a clear understanding of this principle, no time will be wasted in search after perpetual motion machines, and fewer mistakes will be made by really earnest seekers after improved machines for use or improved methods. When a young man brings to me some wonderful improvement over the ordinary crank motion,

1 Page's motor in operation and stereopticon views of the others were here introduced.

1. *Scientific American.*

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some device that is to supersede the crank of the steam engine, a feeling of utter helplessness comes over me; I know not where or how to begin; he has had no opportunity to learn the simple laws of mechanics, and to point out the fallacy of his argument means to teach him the laws of mechanics, so I can only say to him, "Don't," and may advise him what books to read.

We hear or read almost daily of the wonders of science, and what is to be accomplished by electricity. "It is to be the great power of the future." Is it a power now? We may use it indirectly to drive machinery, we may make use of it to propel the cars on our street roads, but is it a power in the sense that steam is a power? Let us think of this a few moments. We call steam a power, and our factories are driven by steam power; or we call water when falling a power, and we drive the machinery in other factories by water wheels; or we pump water into the reservoirs at Fairmount by water power. Where we have no fall of water, and where fuel is scarce but wind plenty, we grind corn in a mill driven by wind, and the wind is our power; these and other sources of power may be called primary powers.

Secondary power is that which is transmitted from the prime motor to a machine. One machine may be driven by belt power, and another may be driven by gearing, etc. Electricity, as we now use it, as a power must be classed in its greatest economy with the secondary powers, with the belt or the gearing, not with the steam engine and the water wheel. We dig from the earth coal that contains the stored up energy of the sun's heat expended on forests that existed long before man came to live on this planet. We burn that coal under our boilers, and the steam generated by this application of heat to water is used to drive the piston of the steam engine, and from thence is the power conveyed by belt or gearing by shafts, or even by electricity, to the machines to be operated. We can burn up zinc in costly acids, and generate electricity that can be used to drive an electric engine, and so in turn operate machines exactly as in the case of the steam engine. In this case electricity is a power exactly as steam is to be considered as a power; and what is more, the electric battery will give us more nearly the whole of the stored up energy of the metal eaten up in the battery than the most improved steam engine can give us of the stored up energy of the coal that is devoured in the furnaces under the boilers. With all this advantage, electric batteries are not used to drive machines with any hope of economical results.

Zinc has been gathered from the earth as an ore, it has been converted into a metal, or the metal has been gathered from the ore by means of coal and much labor; its market price is measured by the cost of its production. To burn up zinc at 5 cents a pound in acids costing but few cents per pound, with a certainty of getting from the metal 70 or 80 per cent. of its theoretical energy in motive force, yet makes the venture a more costly one than the burning of coal under a boiler with the knowledge that we are at the best getting but little more than 10 per cent. of the theoretical power that lies hidden in that coal. The electricity that is now lighting our streets, the electricity that is utilized in places to drive the street cars, has behind it the steam engine or the waterfall, the windmill, or some other motor.

By means of a steam engine we drive a dynamo electric machine, and the electricity thence proceeding lights our streets or may be reconverted, with some loss, back into the power that created it; for one dynamo machine can be made thus to drive another, the electricity being carried from one to the other by proper conductors. What, then, is electricity as we now use it in the way of power, but as the belts and the gearing that carries our steam power to the machines? It is a belt with more or less slip. But this is not to remain so forever. The future of electricity as a power is full of promise. The coal we now squander, using but a small percentage of its theoretical dynamic force, is capable of yielding its energy either as heat or as electricity; and the time will come when we will not burn this coal to boil water, and in that boiling lose say 1,000 units of its heat at the moment of the conversion of water into steam, lose all this, never to be getting it back, but we will take from the coal its energy in the form of electricity, we hope in more near ratio to its true value, and then we can convert that energy into whatsoever other form of energy we may require. The best that science can do is to point out just what energy there is in this or that source of power. The most we can hope to utilize of this energy as power will never amount to 100 per cent. Nature gives us nothing without exacting something in payment.

A pound of water is the same as a pound of metal so far as its power from gravity is concerned. In falling through space it will exert just as much force as any other pound weight is capable of doing, and no more; it will do the work due to 1 pound falling at any given velocity less the friction of the machine or of the moving parts. We turn water into steam with a certain knowledge of the power that can be gained by using the elastic vapor as a spring, or we may tear the gases, which combined form water, apart, and use these gases in recombination to produce power, but less power than was taken to tear them apart, never more.

Science has made us so sure of these facts that we can base our faith on them, and with this knowledge we are willing that others than ourselves shall invest their money in machines which are claimed to be able to develop from five drops of pure water inclosed in a ball, power enough to propel the largest steamship across the ocean. It is ignorance of the unalterable laws of physics that leads ignorant people into squandering money on so-called wonderful inventions that, out of nothing, are to give us great results. An ignorant man will spend his time pondering over perpetual motion machines, so will a man with brain gone wrong; the first will quit his folly with more learning, the second finds his home in a madhouse. A third and worse class aim to deceive, and, for a time, many a one has done so. When shrewd ignorance resorts to dishonest methods, the confiding public is apt to suffer in pocket

THE METRIC SYSTEM.

We call the attention of our readers to the following remarks by Sir William Thomson during an address at Philadelphia last summer: "You in this country are subjected to the British insularity in weights and measures; you use the foot and inch and yard. I am obliged to use that system; but I apologize to you for doing so because it is so inconvenient; and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English minister, whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes. I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change, and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform."

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ELECTRIC RAILWAY PROSPECTS.

VIEWS OF EMINENT ELECTRICAL EXPERTS.

THE possibility of the practical application of electricity as a motive power for such an important service as that of the elevated railways in New York city, has awakened renewed interest in this subject. Under the auspices of the *Mail and Express,* several interviews have been made public, which contain information of interest and value to all electrical workers. In a letter to Cyrus W. Field, Prof. Moses G. Farmer gives the following summary of the history of electro-locomotion :

MY DEAR SIR.—Now that the application of electricity to the elevated roads is agitated, it occurs to me that it may be interesting to glance at some of the steps in the progress of discovery and invention which made electro-locomotion possible in 1850 and practicable in 1883-4. It was in 1819-20 that Oersted, of Copenhagen, discovered that if a wire carried a current of electricity from south to north over a magnetic needle, it caused the north end of the needle to be deflected towards the west, and also, if the current passed from north to south under the needle, the deflection of the north end of the needle was still towards the west.

It was not long before Schweigger carried the wire and current several times over and under the needle and thus invented the galvanometer. Before 1826 Sturgeon had wound a wire several times around a bar of soft iron, and, when a current of electricity was sent through the coiled wire spiral, it made a temporary magnet of the iron bar, which magnetism remained as long as the current was flowing. Soon after, as early as 1831, Faraday discovered the principal facts of magneto-electric induction, and thus made the magneto-electric machine possible in the hands of Pixii in 1832. The Daniell and the Grove batteries soon after appeared, and in 1839 Jacobi, at St. Petersburg, constructed a boat which he propelled upon the river Neva with a two-horse power electro-magnetic engine, actuated by a Grove battery which had in it twenty square feet of platinum surface.

In 1840 Davenport and Cook, of Vermont, constructed a walking-beam engine with which they drove a printing press, using a zinc and copper battery with a solution of blue vitriol as the exciting liquid.

In 1842 Davidson, of Scotland, constructed a five-ton electric locomotive, which he propelled at the rate of four miles per hour with seventy-eight pairs of zinc and iron in sulphuric acid solution, the plates being thirteen inches square.

In 1844 Channing conceived the idea of substituting an electro-magnet in place of the permanent steel magnet in the magneto-electric machine of Pixii, and the further idea of using this electro-magneto electric machine to excite the field magnets of a still larger electro-magneto electric machine.

(This idea was subsequently, in 1863-6, further elaborated by Henry Wilde, of Manchester, England.)

In 1847 I constructed and exhibited in public an electro-magnetic locomotive, and with forty-eight pint cup cells of Grove nitric acid battery drew a little car carrying two passengers on a track a foot and a half wide.

In 1850 Page, of Washington, constructed an electro-magnetic engine of 16 h. p., and with a hundred cells of Grove nitric acid battery, each having platinum plates eleven inches square, he propelled a car carrying a dozen or more passengers on the Washington and Baltimore Railroad at the rate of nineteen miles per hour.

In 1851 Thomas Hall, of Boston, (then at work for Daniel Davis) constructed, and later exhibited at the Charitable Mechanics' Fair in Boston, a small electric locomotive which took its current from a stationary battery by means of the rails and wheels, as the following extract from a letter written to me by him, November 25, will show : "In the year 1851, when I was at work for Daniel Davis, I made a small electric locomotive, which ran on a straight track about twenty feet long. The wheels were insulated and the electricity was conveyed to the engine by means of the rails from two Grove batteries. The cut-off was in the engine and worked automatically or by hand, so that when the engine reached the end of the track, the switch reversed the engine and it went back to the starting point. In 1860 I exhibited in the Mechanics' Fair a small locomotive called the Volta, very finely made and finished, which ran on a circular track about eight feet in diameter. The current was conducted to the insulated wheels from two Grove batteries by means of the rails. I have a part of one of these engines on hand now, and photographs of the Volta; also wood-cuts of the first ones which were published in a catalogue between 1851 and 1860."

I asked Mr. Hall's permission to publish his letter, and in reply he says : "Shall be glad to have you publish the facts as I have stated them to you, and shall be obliged to you for doing it. You know they are facts as well as I do."

These four engines, therefore, of Davidson, Farmer, Page and Hall could be started and stopped, sent forward or backward, at the pleasure of the engineer.

In 1859 I conceived of the self-exciting dynamo, which I constructed in 1866 and which was also conceived of by Wheatstone, Siemens and Ladd in 1867 and by Gramme in 1871, so that by 1871 cheap electricity became possible, and nothing more was needed except to substitute the dynamo machine for the galvanic battery to make electro-locomotion both possible and cheap, and yet the invention slumbered on for a decade or more.

Now, in 1884, a host of inventors, by simply substituting the now well-known dynamo for the more expensive and troublesome acid battery, appear to be just on the eve of bringing to blossom and fruitage those buds of promise after their long forty years of germination, because there was then no demand, no elevated roads, and so they came not forth.

There are two principal methods of propelling an electric locomotive: 1st. The engine carries its source of electricity, such as a galvanic battery, as did Davidson's, Farmer's, and Page's. 2d. It is picked up from a stationary source by means of the wheels and rails, as did Hall's.

In the later days, since the advent of the storage battery, the supply of electricity can be economically carried on a tender, and it is worthy of very patient and long experimental inquiry, which method is the cheaper—to lay a third rail to carry the current to the locomotive, or to charge the storage battery, place it on a tender and attach it to the locomotive.

Respectfully yours,
MOSES G. FARMER.

NEW YORK, Nov. 29, 1884.

In a subsequent interview, Prof. Farmer gave further details of his personal experience, as well as his opinion of practical success in the proposed application of electricity, which is reported as follows :

"I constructed an electric railway nearly 40 years ago. It was only a toy affair, but I thought I had discovered how to make a million or two in a week or two. I expended much time and money, and my contrivance attracted attention throughout the whole country, and was exhibited in several cities. I was a teacher at Dover, N. H., at the time, and I suppose Morse's invention of the telegraph turned my thoughts to electrical enterprise. It was in 1846 that the first telegraph line was built from Boston to Portland, and at the beginning copper wire was used, but it sagged so much that iron was substituted for it. I bought 300 pounds of the discarded wire for my experiments. A man by the name of Davenport had used electricity to operate a printing press in Vermont, and that fact probably helped to convince me that it could also be applied as motive power for railway trains."

"What kind of a motor did you use ?"

"An electro-magnetic motor. The Grove battery was then the most successful invention of its class, and the one I used contained 50 cups and consumed 8 pounds of the acid and zinc per hour for every h. p., the cost being 15 or 20 cents."

"Why did not your scheme succeed ?"

"The power cost too much. In 1850, 3 years later, Page constructed a similar motor with 100 cups, and the government gave him $20,000 for its development for use in the navy, but he did not succeed any better than myself. My enterprise decided the course of my life, however, for I have been engaged upon electrical problems pretty much ever since."

"And have you retained your faith in the practicableness of operating railway trains by electric motor ?"

"I have, and there is reason to expect that its demonstration will soon be witnessed on the elevated railways."

"How would you advise the Manhattan Company to proceed to effect that result ?"

"In the first place, much skill will be required in the test for the selection of a motor."

"But has that not been provided in the expert commission chosen to appraise and consolidate the rival motor interests ?"

"Yes, the members of the commission are satisfactory, if only they will serve, but I do not see how Sir William Thomson can spare the time for the service, unless he is offered a great pecuniary inducement. However, it may take 6 months to prepare the track and motors, so that he

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can devote his summer vacation to it. It might take 60 days for the test after all is ready."

"Have you studied the elevated railways with a view to the change from steam to electricity?"

"Yes, I have had my assistant examine the Ninth and the Third avenue lines. It seems that there are frequently 20 to 25 trains on each track at one time, and each locomotive has about 40 h. p., they say. Of course it will require 20 times as much electricity to move 20 trains as it would to move 1 train."

"Do you mean that a greater force will be required than can be applied with safety?"

"No, not if the proper methods are employed. I do not care to say at present what those methods are, for I am making investigations which I am not yet ready to disclose. I will say, however, that the trackmen will need to wear dry rubber shoes, and even then it may not be comfortable to touch both rails at the same time."

"Will the size of the rail make any difference as to safety?"

"Yes, the larger the rail the less the risk. The central rail should be at least 70 pounds, and the Manhattan Company may be glad if it is not found necessary to take up the 50 pound rails now in use and lay a much heavier track."

"How much cheaper will electricity be than steam power?"

"It all depends upon the system used. There ought to be no difficulty, however, in saving 100 to 140 pounds of coal per hour on each of the 40-horse locomotives now in use, if their consumption of fuel has been correctly represented to me. Stationary engines are much more economical than locomotives, and in Lowell, Mass., a steam pump is operated by only $1\frac{3}{4}$ pounds of coal per h. p. per hour, and I have no doubt the Manhattan Company can save much labor as well as fuel by the proposed change."

"Do you expect to see electricity substituted for steam on surface railways?"

"The problem becomes more difficult when transferred to surface lines, certainly, and I am not prepared to say what I expect, either as to the great freight and passenger railways or as to the street car lines of cities."

"Do you believe, like Mr. Edison, that some one will discover how electricity can be generated directly from coal?"

"The thermo-electric battery to which I devoted so much attention, especially from 1865 to 1868, was too expensive, and it converted not more than $\frac{3}{10}$ of 1 per cent. of the energy of coal into electricity. One of my batteries cost $1,000, and was used to apply the copper to the first compound wire ever made, but it gave no key to the economical production of electricity directly from coal, nor has any other contrivance of which I have yet heard."

Prof. Morton, President of the Stevens Institute of Technology at Hoboken, while entirely convinced of the feasibility of the proposition, strengthens his opinion by carefully refraining from enthusiastic exaggeration. He is reported as saying:

"I think some of the electricians are wild in their estimates, but I am convinced that electricity can be advantageously introduced on the elevated railways of New York. I have read the recent newspaper articles on the subject, and while I think it necessary to make a large allowance for exaggeration, I heartily concur in their general conclusion that the scheme to substitute electricity for steam as motive power on the lines of the Manhattan Railway is perfectly feasible. I should not put the maximum of saving at more than 30 per cent., and the actual amount might be much less. I see that most of the men who have motors to introduce make the minimum about 30 per cent. and confidently predict a saving of 50 per cent. I should say that the cost of generating steam in a stationary engine and in a railway locomotive is as one to two. Clarke, a very high English authority, gives as a result of numerous experiments what is equivalent to 5 pounds of coa per h. p. per hour as the efficiency of locomotives, and recent experiments of the Pennsylvania Railway support his conclusion. As I have said, the plan to operate the elevated railways by electricity is perfectly feasible, and the economy of the new system would doubtless be very important, while the removal of smoke, dust, and some other disagreeable features of the present system would of itself afford adequate compensation for the change, were there no pecuniary advantage to be derived from it."

"The Siemenses use a dynamo as the motor on their electric railways in Berlin and other European cities, and each of the rival motors is a dynamo in a modified form. There is a double magnet surrounding an armature, and the current of electricity passing through the mechanism of this machine on its way from the central rail to the outer ones, by which it is to return to its source, causes the armature to revolve by magnetism, and thus the machine is made to move."

"Is there danger in its use?"

"No, and the current of electricity required would not be strong enough to do injury, either by causing fire or shock. Care should be taken, however, to secure uniformity of current, and there is a great difference of the dynamos as to the production of a uniform current. A force of 1,000 volts, if the current could be made uniform, would not be unsafe, I think, but of course no such force is contemplated in the estimates of the owners of the motors."

"Is a third rail necessary?"

"It would be possible to use one of the ordinary rails to carry the current and the other to return it, but this would require insulation of the rail and of the car wheels, making the problem more difficult. An insulated third rail for that service would be much better. I do not believe that electricity can be profitably substituted for steam on ordinary railways, at least for the present. Improved methods of generating electricity may ultimately make the change economical, but science has not yet made electricity available as motive power for railways, except on short lines. It is absurd, too, for electricians to talk of applying electricity on surface lines without an insulated track. Much of the calculation of enthusiastic inventors will be found seriously at fault in practice, I fear. Short lines which have numerous trains can be successfully operated by electricity, but the same cannot be said of ordinary surface lines."

"Are you also skeptical as to the substitution of electricity for horse power on tramways?"

"I do not see any reason to believe that the change can advantageously be made. The difficulties to be overcome are numerous, and some of them are of a very serious character. I doubt if the change will be made for many years to come."

Prof. Charles R. Cross of the Massachusetts Institute of Technology, who has been asked to serve upon the commission of experts, pointed out some of the difficulties which would be encountered in deciding upon the most satisfactory system to be adopted.

"There is much disagreement," he said, "even among experts, as to the methods of testing electrical apparatus, and it is difficult to secure an agreement as to the comparative merits of electrical machines. However, the Philadelphia Exhibition did much toward the establishment of correct methods of making tests, and I regard the testing of dynamos there as the most satisfactory work of the kind yet done. It will be more easy for the expert commission to perform its allotted task because of the tests made at Philadelphia, but it may require considerable time to determine what motor is best and what system should be introduced."

"If electricity can be substituted for steam as motive power on railways there will be a vast amount of money for the inventor who produces the motor which performs the desired service."

"But do you doubt that the achievement is possible?"

"I do not say that I doubt its possibility, and I will say that

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I think electricity can be advantageously substituted for steam on the elevated railways if anywhere, but there are so many things connected with the enterprise which are yet to be determined that I am not willing to express any opinion as to the results of the experiment."

"You may say that I think the change from steam to electricity will be advantageous pecuniarily, but I will not venture any prediction as to the per cent. to be saved. I think the problem to be considered by the commission is extremely important, both scientifically and pecuniarily, and I prefer to hold my opinion in reserve until investigation has removed some uncertainties which now enter into the case."

"Have you no prediction to make for the encouragement of the railway men who wish to apply electricity as a motive power?"

"Mr. Lowell says: 'Never prophecy unless you know,' and I think his rule is a safe one for me in the case you now present."

"What is the chief factor in the problem—the amount of power required, or the cost, or the risk to life and property?"

"Each of the three factors is important, but I do not think there will be danger in the use of electricity to move railway trains if proper precautions are taken."

"What force can be used with entire safety?"

"I should not hesitate to receive the shock of the current used on most of the electric railways now in operation, although their traffic is nothing like that of the New York elevated railways."

"What force would be required, supposing the number of trains on one track at one time to be 25 and the power of the locomotives now in use to be 40 horse?"

"It would be easy to make an accurate estimate, but without going into a careful calculation I should say roughly about 500 volts with a 1,500 ampère current. That would be approximately the equivalent for the steam power now employed, not taking into the consideration the element of waste in heating the wires. It might be advisable to use lower electromotive force and a higher current."

"But the inventors of the motors do not contemplate the use of so great a force?"

"It remains to be seen whether their expectations will be realized. However, there ought to be no danger in the use of even a much stronger current than I have mentioned."

"And as to the cost?"

"That must be ascertained by a test. The problem is to obtain the maximum of energy at the minimum of expense. The earlier dynamos were constructed with a great internal resistance, but that resistance has been much reduced in the recent inventions. The water-wheel gives the greatest per cent. of the original energy, and in some wheels it is as high as 95 per cent., but the recovery in some of the dynamos is said to be as high as 90 per cent., so that the prospect, from an economical point of view, is encouraging."

There are few people so well qualified to judge of the successful and economical transmission of power through the agency of electricity as Mr. Edward Weston of Newark, N. J. After briefly narrating his preliminary experience in the electrical field, he said:

"I do not wish to appear too sanguine, but electricity is certainly destined to play a much more important part in the economy of civilized life than most people dream of. The crudity and wastefulness of our principal motor, the steam-engine, is very seldom thought of by any except those who have made a special study of the subject. This apparently perfect piece of mechanism wastes nearly 80 per cent. of the energy of the fuel. The dynamo-electric motor would change all this, if we could convert the energy evolved in the combination of coal with oxygen directly into electricity. The dynamo machine will convert more than 90 per cent. of the power transmitted to it into useful energy, and good electric motors would certainly not fall far short of it.

"I suppose that the capital now invested in electrical enterprise, aside from telegraphy, is not less than $100,000,000. And the transmission of power I regard as a much more important branch of electrical enterprise than that of furnishing illumination. It is hardly true, as President Morton, of the Stevens Institute, says that 10,000 mechanical engineers are needed for every ten electricians, and certainly the development of electrical enterprise which the future promises must excite the keenest anticipations."

"How do you arrive at your conclusion that the transmission of power is more important than the production of light by electricity?"

"It is true that the transmission of power by electricity is still in its infancy, but the United States company would be willing to take a contract for the operation of the trains of the elevated railways by electricity, and as long ago as 1880, I made estimates which I presume to be still in the possession of the Manhattan company or some of its representatives.

"But in the operation of light machinery electricity is a safer, more convenient and more economical agent than steam. The small steam-engines now in use are expensive and not altogether safe, and it would be better for all concerned to remove them and substitute electricity.

"Dynamo stations would be required in districts of convenient size, with wires to transmit the power to consumers. A small dynamo—that is, a motor, which is a dynamo reversed—would be needed by each consumer, but its cost would be less than that of a steam engine of equal power, and it would require no fuel and could be controlled as easily as is an electric lamp.

"Ten h. p. engines and all smaller ones cost their owners more than would their equivalent of power in electricity. The United States company will extend its business in the transmission of electricity as power for light machinery as fast as possible."

"Your confidence in the electric motor is doubtless sufficient to enable you to give a favorable opinion as to the feasibleness of the substitution of electricity for steam as a motive power on the elevated railways, then?"

"I have no doubt whatever that the change can be made with advantageous results in more than one direction."

"Let me give you a problem. Suppose that on one track of the 'L' there are at one time 25 trains, each drawn by a locomotive of 40 h. p. What will be the force of electricity required as a substitute for the locomotives to move the trains?"

"It depends upon the pressure as related to the current. But a pressure of at least 500 volts can be safely used, with the proposed 70 pound central rail, and with that pressure a current of not quite 1,500 ampères would be required as an equivalent for 25 locomotives, each of 40 h. p."

"What size stationary engine and what dynamo would be required to furnish that force of electricity?"

"It would be unwise to use one dynamo to generate that amount of electricity, and about 6 dynamos, each of 200 h. p., would be needed. For the operation of these dynamos a stationary engine of 1,200 h. p. would be adequate."

"And what would be the expense?"

"The rule is that a stationary engine of the best kind costs $50 per h. p. annually, and at that rate the entire expense would be $60,000 a year. But there is this difference between a locomotive and an electric motor. The former has only its minimum power at the start, while the latter has its maximum, and so the locomotives need to have 40 h. p., although the average power required may not exceed 25 horse."

"There are great mechanical difficulties in the case, I admit," said Mr. Weston, in reply to a question, "but what great invention has been introduced without overcoming great mechanical difficulties? The introduction of gas is a good illustration. The opposition to its use was so great that its substitution for the old light was retarded nearly twenty years, and it is now very amusing to recall the objections which were made to it. Dynamite is hardly regarded with more dread now than was gas by many people less than a century ago. Only fifty years ago the citizens of Philadelphia passed resolutions entreating the Common Council not to permit the use of gas in that city, mainly because it was thought to be dangerous. The obstacles to the application of electricity as motive power are certainly not greater than were those encountered by the men who established the system of gas light."

Mr. Edison has also given his views upon the subject through the columns of the *Sun*, by which it will be seen that he considers the economy of electric locomotion settled, and that its immediate application is simply a question of proving it to the satisfaction of the management. He says:

"The application of the electric motor to the car is simple, and could be effected in no time if the men could be found with nerve enough to advance the money. It will need two stations to keep the current on the tracks. I could build one at Washington Park and one near 42d street, and keep all the trains in motion without any trouble, including switching and stops. It can be so arranged that all power will leave the trains as they approach on the same track, and so collisions will never occur. Speaking practically, I will take the 160 engines of the Manhattan company and put half of them in one of the stations I spoke of above and half in the other, to run the dynamos which will furnish a current of electricity. I will then buy enough old rails to reach from the Battery to Harlem and will set them up between the tracks of the elevated road. Wires from the two stations will be connected with this long railing, and the electricity will flow through it. It will be led to the electric motors and after furnishing power to run the train, will be allowed to escape through the regular rails of the road."

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"What will be the saving to the Manhattan company?" Mr. Edison was asked.

"They will save in the number of employés necessary, for one man at each of the two stations can run 15 trains. One man can run the electric motor. The saving in coal will be very great. They can use more economical boilers than at present. To-day their property is depreciating on account of the great wear and tear. The power is now applied explosively, in jerks. There is a terrible racking of the whole structure. They might as well explode powder all along the line as to run as they do now. Electricity, on the other hand, is a continuous, velvety motion. There is no jar and no wear and tear to the structure."

"How soon can the change be made?"

"As soon as the money is forthcoming. The motor has reached such a degree of perfection that nothing more can be done to it in the laboratory. It is now only a question of mechanical engineering, or a draughtsman's work, to apply the motor to the elevated road. An experiment is likely to be made soon on the Second avenue line. If they let me put up my centre railing I can run my electric train right in with the others and not interfere with the steam trains."

"Will any other improvements be made in this connection?"

"There is one that ought to be made now, whether they have an electric road or not. I can increase their travel enormously if they will let me put in an electric elevator at each of the stations. Women will not ride because their clothes are so heavy they can't climb those frightfully long stairs. Old men can't get up there. Just think how nice to step on a platform and rise quietly to the station and come down the same way! Thousands who don't ride now would flock to the roads. The people of New York expend 26,250 h. p. in an hour climbing those stairs. The force consumed averages 2,187 per hour for the twelve hours of the day. Let me figure for you. The report of the Manhattan company says that they carried 50,000,000 people last year. We put these people into pounds, at 150 pounds each, and have 7,500,000,000 pounds. But they must be raised to the platform, which is twenty-five feet high at least, and that gives us 52,500,000,000 pounds raised one foot. The h. p. for an hour is 2,000,000 pounds raised one foot. If all those people were raised to the stations in one hour that would be an expenditure of 26,250 h.p., and dividing by twelve for the twelve hours of the day we get an average per hour of 2,187 h. p. expended by people in climbing those stairs. Why, that is about one-fifth the total power expended in running the whole elevated road. But people don't seem to mind it much—man is such a perfect motor, you see."

ABSTRACTS AND EXTRACTS.

TRANSMISSION OF POWER BY ELECTRICITY.

One of the most successful examples of the transmission of power for industrial purposes by electricity which has yet been made, is described in a recent number of *La Lumière Electrique*. The thriving manufacturing city of Bienne is situated on the Suze, a tributary of the Aar, in Switzerland. The river Suze, which descends from the heights of the Jura, for the greater part of its course is a veritable mountain torrent, but at a distance of about 2 km. from Bienne, it reaches the level land at the foot of the mountains, and is suddenly transformed into a sluggish stream. Several years ago a system of high pressure water works was established in Bienne, deriving its supply from above the lower falls, and not only furnishing an excellent domestic system, but also a convenient motive power to a large number of manufacturing establishments of moderate size, either by means of turbine-wheels or hydraulic engines. The enterprise proved so successful in this respect that the entire available supply was taken up within a brief period, the demand for power proving to be largely in excess of the capacity of the works. Two enterprising manufacturers, M. Roulet, lapidary, and M. Bourgeois, watch-case manufacturer, who occupied the same building and who had been obliged to supplement their water power by means of gas and steam engines, determined to make a trial of electrical transmission.

The volume of available water at the point where the turbines are placed is about 1,500 litres (375 gallons) per second, and the fall is about 54 metres (177 ft.). The Girard turbine which is employed is however capable of utilizing only 400 litres under a head of 46 metres, thus giving about 180 effective h. p. The water is led to the turbine by a tunnel cut through the rock 2 m. (6 ft. 6 in.) high by 1.5 m. (4 ft. 11 in.) wide. The turbine is belted to the dynamo electric generator instead of being directly attached. The dynamo machines used are of the Thury pattern, which is a modified form of Gramme. The distance between the generator and the motor is 1250 m. (about 4,100 ft). The amount of power required by the two manufactories varies from 6 to 18 h. p. One of these is a rolling mill for preparing silver plates for watch cases, and necessarily varies considerably in its requirements in this respect. The other, in which watch-jewels are cut and drilled, requires the utmost possible uniformity of speed. After several experiments a compound winding for the dynamos was adopted, by which a constant speed may be maintained without reference to the amount of power required. The conductors employed are two copper wires of 7 mm. diameter (No. 1, B & S. gauge) suspended in the air upon posts and tied to porcelain insulators in the usual manner of a telegraph line. The generator and the motor are of the same size, both being of the type designated by the makers as H 2. The generator makes 500 revolutions per minute and gives an E. M. F. of 350 volts. The motor makes 400 revolutions, under a potential averaging about 300 volts.

The speed of the motor is controlled by varying the resistance of the line conductor. A box of graduated resistance coils formed of brass wire, is provided with a rotating contact-arm and a series of contact terminals. The arm is operated by a pinion movement communicated through an endless screw, which effectually prevents the resistance from being varied so suddenly as to endanger the coils of the machines. It requires at least 20 seconds to withdraw the entire amount of resistance from the circuit by the screw movement, which gives the motor ample time to work up to its maximum speed after starting. Ordinarily a portion of this adjustable resistance is left in the circuit, for convenience in adjusting the speed of the motor. This provision is necessary, because the proper speed of the machinery for drilling watch-jewels must bear a certain relation to the temperature of the room in which the work is done.

It has been found necessary to furnish the line with lighting arresters at both ends, the locality having proved to be unusually subject to atmospheric electrical disturbances.

This admirable practical application has now been in operation for more than 7 months; occasional interruptions took place at first, which were mainly due to a lack of experience in properly adjusting the commutator brushes, but since the employés have become familiar with the machines these difficulties have entirely disappeared. Careful tests have been made to determine the percentage of power utilized; the results of which are promised in full in a future communication. It is unofficially stated that an efficiency of 70 per cent. has been reached under the most favorable conditions.

This installation is especially interesting as it establishes the entire practicability of the industrial application of a considerable force at a considerable distance from its source, and demonstrates conclusively that the work may be successfully accomplished on a much larger scale if required. The work of the installation was designed and executed by the establishment of Neuron & Cuenod of Geneva.

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ELECTRICITY FOR CITY RAILWAYS.

A LETTER from Professor Moses G. Farmer to Cyrus W. Field, recently published in the *Mail and Express*, contains some interesting calculations as to the saving that could be effected on the Second avenue elevated railway by the substitution of electric motors for the steam engines now in use there.

I assume, says Mr. Farmer, that a stationary plant can be erected somewhere near the middle of the line, not far from Sixty-third street, this plant to consist of one or more stationary steam engines of the best type, capable of developing one h. p. by the combustion of $1\frac{3}{4}$ pounds of coal per hour per h. p. by the use of such coal as does not cost over $2 50 per ton of 2,240 pounds.

I assume that there are in use on this line 20 locomotives of 110 h. p. each at the busiest hour of the day, and that each locomotive consumes—per h. p. per hour—5 pounds of coal that cost $4 per ton of 2,240 pounds.

I assume that the rails now in use are of steel and weigh 70 pounds per yard, and that a central steel rail of 70 pounds per yard will be laid for the purpose of conveying the electric current to the motors.

I assume that 1 mile of such steel rail will offer about $\frac{1}{100}$ of an ohm's resistance, and that the aggregate internal resistance of the dynamos concerned in producing the current will not exceed $\frac{1}{100}$ of an ohm.

I assume that from this central station sufficient current will be supplied to both tracks to energize at the same instant all of the 20 electric locomotives, no matter on what part of the tracks these motors may be situated.

I assume that 1 h. p. is the equivalent of 746 ampère-volts, and that $20 \times 110 \times 746 = 1,641,200$ ampère-volts, in the aggregate, reach these motors.

I assume that such dynamos can be constructed as shall convert 90 per cent. of the mechanical power applied to them into current electricity, and I also assume that such electric motors can be constructed and used as shall convert 90 per cent. of the electricity which they receive into power used to draw the trains which are attached to them.

I assume the Second avenue railway to be $6\frac{1}{2}$ miles in length.

With these assumptions I have calculated the following tables:

TABLE I.

Volts.	Present power.	Future power.
500	2,200	3,369
1,000	2,200	2,879
1,500	2,200	2,787
2,000	2,200	2,757

TABLE II.

Volts.	Present coal.	Future coal.	Saving per hour.
500	11,000	5,896	5,104
1,000	11,000	5,039	5,961
1,500	11,000	4,889	6,111
2,000	11,000	4,825	6,175

TABLE III.

Volts.	Present cost.	Future cost.	Saving per hour.
500	$19 65	$6 58	$13 07
1,000	19 65	5 62	14 03
1,500	19 65	5 46	14 19
2,000	19 65	5 38	14 27

Table 1, column 1, contains the electromotive force developed by dynamos at the central station; column 2 contains the h. p. required by the 20 locomotives; column 3 contains the h. p. that must be used at the central station in order to deliver at the electric locomotives the equivalent of 2,200 h. p.

Table 2, column 1, contains the electromotive force, as in the first table; column 2 contains the hourly consumption of coal by the 20 locomotives now in use—5 pounds per hour per h. p.; column 3 contains the amount of coal consumed by the stationary engine that develops 1 h. p. by the combustion of $1\frac{3}{4}$ pounds of coal per hour; column 4 shows the saving in pounds of coal per hour made by substituting the better engine, the dynamo, the electric motor and the rail circuit.

Table 3 shows the hourly saving in dollars and cents by the substitution of electricity thus applied for the coal now used in the locomotives.

It will be seen from this last table that the lower and safer electromotive force of 500 volts is only about 9 per cent. more expensive than the 4 times as great 2,000 volts, and about 7 per cent. more expensive than 1,000 volts.

I must reserve for another letter my conclusions regarding what would be the savings resulting from the use of electricity on the Third avenue line, as I wish to obtain some further information as to frequency of trains.

JUSTICE AT LAST.

AFTER long and weary waiting, after four years of contest, and an expenditure of money which would have ruined most litigants, a decree has been ordered for the Bell Telephone Co. in its suit against the People's Telephone Co., representing the alleged inventions of Drawbaugh, and the injunction against the People's company is now made perpetual, with the right of appeal, of course, to the Supreme Court, which will doubtless be taken. But, for all practical purposes in the near future, the decision is final, since it will take a number of years for the Supreme Court to reach the case, and in the meantime the defendants are powerless.

As yet we have not seen the full text of the decision, but enough of it has, at the present writing, been made public to show that the judge, in a large measure, bases his opinion upon the inherent improbability of the rightfulness of the claims of Drawbaugh, who, according to his own story, calmly stood by after he had made these important and well-nigh invaluable inventions, and without a word of protest permitted another to reap the glory and the reward. This the judge considers fatal, despite the great mass of evidence adduced in support of the Drawbaugh claims.

We have more than once, while this important suit has been pending, expressed our dislike and disapproval of "trial by newspaper," and certainly now that the appointed tribunal has rendered a learned and exhaustive decision, any judgment that we or any other newspaper might render would be highly unimportant and unnecessary. But we may be permitted to say, now that the case is settled and an award has been made, that we have steadily been of the opinion that the Drawbaugh claims were founded upon a conspiracy to rob men of their just rights under the patent laws. We are very far from expressing the opinion that all or any considerable number of those who have been prominently connected with the enterprise were either cognizant of or parties to the conspiracy. On the contrary, we are firmly convinced that it was part of the scheme to get honorable and innocent men honestly interested, so as to give character and respectability to an enterprise which had none of its own. And we further believe, now that the case has been decided in favor of the Bell company, that the conspiracy, no longer held together by the cohesive power of prospective plunder, will fall to pieces, and that we shall yet see the inside of one of the greatest pieces of rascality ever concocted, to the disgrace of the few who devised it, and the chagrin and mortification of very many more who were honestly misled

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into believing the story to be genuine and staking their money on the result.

Believing this, and feeling that nothing more than exact justice has been done—and who, having read even a synopsis of the evidence, could doubt what the result would be? —we feel like offering our congratulations to the Bell company, and to all who, directly and indirectly, will be benefited by the fact that an end has come to the long suspense. The sub-companies, operating under licenses from the parent company, will take new courage, their work will be extended and enlarged, the number of outstanding telephones will increase, and the whole industry will take a new start.

Of all the men who will receive congratulations no one deserves them more than Mr. Storrow, now taking a well-earned rest in Europe. We venture to say that, for sustained effort, for intimate knowledge of the subject in hand, for exact accuracy in the plain, straightforward recital of facts, their bearing upon one another, and the deductions to be drawn from them, his argument stands alone in the long list of pleas that have been made before the United States Court in patent causes. It was the justice of the company's cause which won the case, but it was the way in which it was put by Mr. Storrow that made its justice apparent.—*Electrical Review.*

MEASURING ELECTRIC CURRENTS.

Lord Rayleigh has suggested the application of Faraday's discovery of the rotation of the plane of polarized light by an electric current as a means of measuring the current. Mr. J. E. H. Gordon found that the reversal of a current of 4 ampères circulating 1,000 times round a column of bisulphide of carbon through which the polarized ray passed, produced a rotation of the plane of polarization of the ray of about $7\frac{1}{2}°$. With heavy glass, which is more suitable for measuring purposes, the rotation is somewhat greater. The method does not seem very promising, but in Lord Rayleigh's hands something may be made of it. It has the advantage of requiring no springs or gravity indicators, the ray of light serving this purpose. One drawback exists in the depolarizing properties of heavy glass. A more useful, if less novel, method of measuring currents by means of the ordinary apparatus is also given by Lord Rayleigh. A standard cell is connected through a high resistance, such as a set of resistance slides, and 2 points in the slide are found which have the same difference of potential on 2 points of a strip of german silver through which the current to be measured is passed. The equality of potentials is found by a galvanometer in circuit which gives no deflection where the 2 points are found. Knowing the difference of potentials on the slides (it is equal to the electromotive force of the cell x, the resistance between the 2 points on the slide divide the whole resistance of the slides), and the resistance between the 2 points on the german silver sheet, the strength of current is easily found by Ohm's law. It is equal to the above difference of potentials divided by the resistance between the 2 balancing points on the slide. This method is well known; but the use of a german silver strip with lugs or projections on it at a given resistance apart to serve for the points of connection in the balance, is a new modification.

THE PROBLEM OF POWER.

A prominent engineer is reported by the New York *Tribune* as saying: "Scientific invention runs in grooves. Electricity has unquestionably been the great development of the past 20 years. While nothing is impossible, I think the limit of electrical invention has been reached. Applications of the inventions already made are engrossing attention. In that direction the great problem is power. It is a singular fact that since the discovery of steam and its application as a motive power there has been no great invention in steam. Now that inventors are applying themselves to extending the electrical inventions, they find cheaper motors necessary. You will see that inventive genius will improve steam making by revolutions as wonderful as any that have taken place in other branches of scientific investigation. What discoveries will be made I cannot predict, but I believe the next step in scientific progress will be in that direction."

LITERATURE.

REVIEWS.

Bell's Electric Speaking Telephone: Its invention, construction, application, modification and history. By George B. Prescott. With 380 illustrations. New York: D. Appleton & Co., 1884.

Dynamo-Electricity: Its generation, application, transmission, storage and measurement. By George B. Prescott. With 545 illustrations. New York: D. Appleton & Co., 1884.

The introduction of the speaking telephone for commercial and business purposes, which had begun to be quite general in this country in the early part of the year 1878, excited in the mind of the average citizen an unprecedented interest in the phenomena of electricity, and in the details of some of its more recent, and at that date surprising applications to industrial uses, and it created an immediate demand for literature relating to the subject, which has not merely continued, but has ever since continued to increase. In the year mentioned Mr. Prescott issued a work under the title of the *Speaking Telephone and other Novelties*, which was, we believe, the first attempt to treat these subjects in detail, and in a manner adapted to the popular comprehension. The general favor with which this work was received led to its reissue with material changes and additions some two years later. In the new edition, a considerable amount of space was devoted to the subject of electric lighting, so far as it had at that time been practically developed. The growth and evolution of the industrial applications of electricity has, however, been so rapid that Mr. Prescott has now found it necessary to depart from the plan of his original work, and to divide its subject matter into two distinct volumes, one of which is devoted to the telephone and the other to the general subject of dynamic electricity, of which electric illumination is at present by far the most important practical application.

The present work on the telephone is evidently designed to be an exhaustive one, and it certainly embraces a far greater amount of information relating to all branches of the subject than any other one which has yet appeared. A portion, perhaps one-third, of the present volume, contains substantially the same matter as the edition of 1880, although this has been somewhat revised, as the progress of the art seemed to render necessary. The remaining portion of the work is for the most part entirely new.

We find here given, for the first time, detailed and fully illustrated descriptions of the principal telephone exchange systems in practical use. The account of the central telephone system in Paris is especially complete, and is moreover exceedingly interesting. The leading systems which are or have been in use in the United States are described at length, especially the so-called "Chinnock" and "Law" systems which are employed in the telephone exchanges of New York city. One long chapter is entirely devoted to descriptions, for the most part well illustrated, of the more prominent of the innumerable modifications, improvements and mis-improvements which have been made by others upon the original invention of Bell. Among these, however, the Blake transmitter is passed over with a description much more meagre than would seem to be warranted by its unquestionable merit as an invention, and the enormous extent to which it has been adopted and used in connection with the fundamental invention of Bell. By some unaccountable oversight, no mention is made of the Hunning transmitter, which has developed such a surprising capacity for the transmission of articulate speech to great distances, and which has, we believe, been definitely adopted by the American Bell Telephone Co. for its long lines, such for instance as that between Boston and New York—a distance, as the wire runs, of perhaps 275 miles.

The space which has been devoted to a description of some of the abortive conceptions of Edison having no particular relation to the subject in hand, such, for example, as the "aerophone," the "harmonic engine," the "megaphone" and the "phonometer," might perhaps have been utilized to better advantage in giving some account of the individual-call system, one of the ingenious outgrowths of the telephone exchange which has found

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a not inconsiderable application in practice, especially in sparsely settled localities.

Another chapter is devoted to the history of the invention of the speaking telephone, embodying a considerable amount of interesting information not hitherto accessible to the general public. It contains, among other things, the substance of the able and exhaustive report of the Examiner of Interferences in the United States Patent Office, in which the entire history of the invention, as developed by the several claimants, is set forth with great minuteness. While we entirely agree with the conclusion of the author that Bell was unquestionably an original inventor as well as legally the *first* inventor of the speaking telephone, and that it is to him and those associated with him to whom the world is indebted for the benefits of this invention, yet we feel compelled to dissent from the somewhat summary manner in which he dismisses the claims of Elisha Gray. The evidence in support of Gray's claim is perhaps sufficiently well presented by Mr. Prescott, the facts as between Bell and Gray appearing to be simply these: Prior to 1875 Bell had dimly conceived the possibility of transmitting and reproducing articulate speech by electricity. On June 2d, 1875, he accidentally noticed that very slight vibrations of a thin armature in front of a magnet induced magneto-electric currents capable of appreciably affecting a receiving instrument—a fact which gave him the key to the telephonic problem. Under his direction, his assistant Watson immediately constructed a pair of membrane instruments, which were tried in June and July, 1875, but with exceedingly unsatisfactory results, although in the light of present knowledge it is plain enough that articulate speech might have been, and probably in fact was, transmitted by the apparatus as then used, although the ear of the listener, being as yet untrained, was not able to detect it under the conditions of the experiment. Nevertheless, in the latter part of 1875 and the early part of 1876, Bell prepared a specification which he filed on February 14, 1876. This document contained a drawing and description of an apparatus which was substantially that used in the experiment of June, 1875. It appears, however, that until after the time of the issue of this patent, March 7, 1875, the invention was not successfully reduced to practice.

The so-called lover's telegraph, a street-vender's toy consisting of two membranes united by a string, suggested to Gray, in December, 1875, a definite idea of the true principle of the speaking telephone. He did not disclose this conception to others, nor reduce it to form until February 11th, 1876, when he made a sketch from which a caveat was prepared, which by one of these remarkable coincidences which are of such frequent occurrence in the history of invention, was filed in the Patent Office on the same day as Bell's application, and only a few hours later. It seems well established, however, that until after this date neither Bell nor Gray had any definite knowledge of the character of each other's work. The caveat of Gray contains a far more complete exposition of the principle of the transmission of articulate sounds than the patent of Bell, and it seems certain that at that date, he was farther advanced upon the right road than his competitor. For some reason, however, he was dilatory both in reducing his invention to practice and in filing his application for a patent, and thus it happened that Bell, who had been the earliest to definitely conceive the invention, was also the first to obtain a patent, and the first to reduce it to actual practice, which he appears to have done on the 8th of May, 1876. Singularly enough, it has been shown by the evidence taken in the Drawbaugh case, that the first transmission of speech was accomplished by Bell with an instrument substantially the same as that described in Gray's caveat, and entirely unlike that shown in Bell's own patent. Without, therefore, detracting in the least from the claims of Professor Bell, it would seem that Mr. Prescott has scarcely given Gray his due in his summary of the history of the invention.

Mr. Prescott gives a curious bit of the inside history of the controversy between the Western Union Telegraph Company and the Bell Telephone Company, and of the negotiations which led to the existing alliance between these organizations. He says:

> The history of this controversy shows how great results sometimes follow insignificant causes. In the summer of 1875 Mr. Bell asked permission of the Western Union Telegraph Co. to conduct experiments in the office of their electrician at New York. This was granted; but shortly after Mr. Bell began his experiments there, Mr. Orton, the president of the company, learned that Mr. Gardiner G. Hubbard, who was personally obnoxious to him, was pecuniarily interested in Mr. Bell's inventions, and immediately directed that the permission to conduct his experiments should be withdrawn. After Mr. Bell had brought his invention before the public, and was endeavoring to perfect it by experimenting over actual telegraph lines, orders were given to exclude him from the Western Union wires. In spite of these orders, however, telephone experiments were conducted over them; but for a long time the results, while regarded with interest, were looked upon as possessing little practical value, and it was not until the summer of 1877 that the progress of Mr. Bell's invention was deemed to have arrived at such a state of efficiency as to threaten to be a serious competitor of the telegraph. At this juncture, August, 1877, Mr. Frank L. Pope, the electrical expert of the Western Union Telegraph Co., saw and talked through a speaking telephone in Boston for the first time, and soon after mentioned the fact to Mr. Orton, who said: "I have been looking into this matter of the telephone somewhat, and regard it as a matter likely to be of considerable future importance. If this proves to be the case, it is very necessary that we should have the right to use it; therefore I wish you to make a careful and thorough investigation of the whole subject, and ascertain what are the fundamental principles of the invention, and what inventions or patents it will be desirable or necessary for us to acquire the control of, in order to be able to use the invention in connection with our business."

The result of the expert's report was that the right to Gray's inventions was acquired, in addition to those of Edison w ch the company already controlled, and the manufacture and leasing of telephones was commenced through a sub-company known as the Gold and Stock Telegraph Company. An action for infringement was at once instituted by the Bell company, which was in progress during the summer of 1879. Mr. Prescott says:

> After a very vigorous defence had been made by the Gold and Stock Telegraph Co., and testimony at great length and great expense had been taken in support of the answer, and the testimony was substantially closed on both sides, Mr. Gifford (the leading counsel for the Western Union) became convinced that Bell was the first inventor of the telephone, and that his patent had been infringed by the use of the telephones in which carbon transmitters and microphones were elements, and that none of the defences which had been set up could prevail against him, and advised the company to that effect, and suggested that the best policy for them was to make some settlement with the Bell company.
>
> For the purpose of effecting such a settlement, the position of the Gold and Stock company was very strong. They controlled, through the Western Union Telegraph Co., the celebrated Page patent, which covered the induction coil used in the transmitters of the telephone, and was of great importance to them, and which the Bell company were using.
>
> Under Mr. Gifford's advice a negotiation was opened with the Bell company on the basis of the claims which the Western Union Telegraph Co. made, that the telephone used by the Bell company was an infringement of the patents and applications for patents owned or controlled by the Western Union Telegraph Co. Mr. Gifford met Mr. Chauncey Smith, counsel for the Bell Telephone Co., by arrangement, at the White Mountains, where they remained for a week in negotiation. Mr. Gifford opened the negotiations by admitting that Bell's patents were valid, and that the Gold and Stock company infringed them, and these questions formed no part of any discussion between them, but claimed, on the part of the Gold and Stock company, in view of their patents, that all the patents should be put together, and that they should have one half in the joint property. This claim was refused by Mr. Smith, and the negotiations failed at that time. After Mr. Gifford's return, Mr. Prescott, the vice president of the Gold and Stock Telegraph Co., then in charge, had an interview with Mr. Causten Browne, who coincided in Mr. Gifford's views, and said that the Court would undoubtedly sustain the Bell patent of March 7, 1876, the fifth claim of which, viz., "The method of, and apparatus for, transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth," covered all electric speaking telephones in use. Upon the receipt of this advice, negotiations were immediately reopened with the Bell company, and soon resulted in a contract, in which, instead of the Gold and Stock company and its associates getting one half of the joint property for the inventions which they contributed, and which were essential for the satisfactory operation of the best telephone system, they got only 20 per cent. of the earnings, and agreed to go out of the business and never to make use of any telephones, excepting such as they should acquire the right to use from the Bell company and pay them the market price for, the same as other people have to do. They transferred to the Bell company their exchanges for cost, and sold them their instruments at 25 per cent. less than cost, and thus ended the first attack on Mr. Bell's invention of the electric speaking telephone.

The reader will find the history of the claims of various rival claimants to the invention, or to some portion of it, including McDonough, Dolbear, Voelker, Edison, Drawbaugh, etc., given at length, with copious extracts from the opinion of the Examiner of Interferences in which he passed upon the evidence presented in behalf of each.

In an appendix to the work, the decision of Judge Lowell in the case of the *American Bell Telephone Co.* v. *Spencer*, and that of Judge Gray in *American Bell Telephone Co.* v. *Dolbear*, are given in full, which will be found convenient for reference.

The mechanical execution of the book is excellent, and the illustrations are not only profuse, but are far more artistically executed than has of late been usual in works of this description.

We find that we have scarcely left ourselves space for an adequate notice of Mr. Prescott's work on dynamo electricity, which is for the most part a descriptive one, although a considerable amount of historical information is given. The first two chapters of the work are substantially unchanged from the edition of 1880, and give a sufficiently satisfactory exposition of the subject as it existed at that date. It is a question, however, whether it would not have been a better plan either to have omitted these chapters, or to have placed them by themselves in an appendix, as they really contain but little material which is of value in the present state of the art. These chapters, however, form but a small portion of the work; the remainder contains an amount of useful information upon the general subject which it would perhaps be difficult to find elsewhere within such moderate compass.

Something like 100 pages are devoted to an exceedingly well illustrated description of the Edison system of electric lighting, including not only the generators, lamps, conductors and fixtures, but the process of manufacture as well. The account of the central station lighting system in New York city is particularly complete, and will be found of much interest. It would seem, however, that the information might have been brought down to a later date, for no mention is made by Mr. Prescott of the improved Edison-Hopkinson dynamo, which we believe is now used by Edison in lieu of the older forms, nor of the ingenious three wire system of distribution which has been in operation in Brockton, Mass., and elsewhere, for a year or more. Mr. Prescott gives credit, and we believe properly, to Edison as the first to adequately appreciate the economical advantages of an exceedingly low internal resistance in the generator. He also attributes to him the invention of the sectional armature made up of thin discs of iron, whereby the injurious eddy currents are broken up. This, however, is a mistake; Mr. Weston undoubtedly constructed an armature in this manner at least as early as 1874, and described it in an application for a patent filed by him on June

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4th, 1878, which was before Edison took up the question of dynamo machines at all. The extraordinary size and partial saturation of the field magnet in the earlier forms of the Edison dynamo are also mentioned as advantageous, but experience has demonstrated that this is not the case, and accordingly the field magnets of the later machines have been largely reduced in weight, while their efficiency has at least not been diminished by the change. The Maxim, Swan, Weston, Bernstein and Lane-Fox incandescent lamps are sufficiently well described, and the reports of the tests of these and other incandescent lamps at the Paris Exposition of 1881, with the tabulated results, are given at length.

Turning to the chapter on arc-lamps and regulators, the reader will find described and illustrated almost every one which has attained any prominence whatever. The author has very properly paid particular attention to the descriptions of the lamps principally in use in this country, as being of more importance and interest than others.

In the chapter on dynamo-electric generators, the principle of the machine is first set forth, and this explanation is followed by a description of the principal inventions of this class now in use throughout the world. We note particularly an illustrated account of Hjorth's machine, which was patented in England in 1855, and which in fact embodied the great discovery of the mutual interaction of the armature and field which constitutes the fundamental principle of the modern dynamo. The portion of this chapter which relates to the work of Mr. Weston and the evolution of the remarkably efficient dynamo machine now so well known by his name, is noticeable for its clearness and completeness. We find here for the first time an adequate description of Weston's self-regulating dynamo, of which the electromotive force remains constant under all variations in the resistance and the external work, a machine which excited the utmost interest and admiration among the scientific visitors at the recent Philadelphia exhibition.

A brief account is given of the more prominent of the electric motors which are of interest either from a historical or a practical point of view, together with a succinct account of the different electric railway systems which have thus far been brought forward.

The final chapter, which treats of electrical measurement, and especially of the measurement of powerful currents, is deserving of unqualified commendation. We know of no treatise which will bear comparison with it, either in its masterly exposition of the principles upon which the methods of measurement are founded, or in the clear and satisfactory manner in which these methods are explained so as to render them available to the practical electrician and experimenter. Almost every one of the recently invented instruments adapted to this class of measurements is fully described and illustrated, and its excellencies and defects pointed out. The adaptation of particular instruments to particular methods of testing are also suggested, and the sources of probable error indicated. To the student, the experimenter and the electrical engineer, this portion of the work will be simply invaluable, and Mr. Prescott could confer no greater favor upon the profession than to republish it separately in a compact form convenient for the pocket and the laboratory table.

Stationary Steam Engines, especially as adapted to electric lighting purposes. By ROBERT H. THURSTON, A. M., C. E. New York: John Wiley & Sons, 1884.

THE electrical engineer of the present day who aspires to a more than superficial knowledge of the higher branches of his profession, must include the subject of mechanical engineering—at least so far as it has to do with steam-engines and the use of steam power – among his subjects of study. The development of the steam-engine within the past few years, due mainly to the exacting conditions as to efficiency, regulation and smooth action at high speeds arising from the requirements of electric lighting, has been very great. At the request of the editor of this journal, Professor Thurston prepared, some time since, a series of papers containing a systematic outline of the evolution of the now accepted type of high-speed engine for electric lighting plants, in such form that the causes of the various modifications of construction and operation which have resulted therefrom might be readily understood. Many of our present readers are familiar with these papers, which appeared in our columns during a portion of the years 1883 and 1884, and will doubtless be pleased to know that they have been reprinted, with corrections and some additions, in a neat little volume of 187 pages. Professor Thurston, who is one of the best of authorities on this subject, has studied his subject in connection with descriptions and discussions of representative standard types of engines. The electric light engineer will here find set forth the distinctive characteristics of nearly every one of the modern stationary engines which have proved themselves especially adapted to his work, and will find Professor Thurston's analysis of the subject of great value in making an intelligent choice for the particular purpose which he may have in hand. The book is handsomely printed and well illustrated, and while indispensable to every electric light engineer, is by no means without value in other departments of industry.

Map and Plan Drawing. By C. COOPER KING, Lieutenant Royal Marine Artillery. New York: Cassell, Petter and Galpin.

A FEW years since a treatise on map and plan drawing would have had no possible relation to the ordinary work of the electrical engineer. At the present rate of progress, however, he will soon be called upon, among other things, to lay out electric railways and hydraulic works to provide for the transmission of power by electricity from inaccessible places where it is not wanted, to accessible places where it is wanted In this class of work, a knowledge of the subject of Lieutenant King's little work will be found to be of material value. Although the subject is treated mainly from a military point of view, the instructions are equally applicable to the work of the civil engineer. We have seen no treatise so well adapted as this to serve the purpose of the busy man who desires to obtain the greatest possible knowledge of the subject with the least expenditure of time and trouble. The volume is in handy pocket form, and may be carried about and studied at leisure.

RECENT PUBLICATIONS.

Buchanan, W. M. Dictionary of Science and Technical Terms. New York, *Scribner & Welford*, 1884. 12°. 824 p. Cloth, $2.40.

Bowser, E. W. Elementary Treatise on Analytic Mechanics. New York, *Van Nostrand.* 515 p. 12°. $3.00.

Matheson, E. Depreciation of Factories. New York and London, *E. & F. Spon.* 8°.

Paice, W. Energy and Motion; a text-book of elementary mechanics. London, *Cassell*, 1884. 116 p. 12°.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents. Anonymous communications cannot be noticed.

The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.

In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.

Sketches and drawings for illustrations should be on separate pieces of paper.

All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

THE EDISON ELECTRIC LIGHTING SYSTEMS IN THE UNITED STATES.

[28]—In reply to your letter of the 8th inst., I beg to state that the total number of incandescent lamps in the United States at the present time in isolated plants is 75,000, and in central stations 34,800, making a total of 110,000 lamps in all, within the United States, which would represent 14,000 h. p. The most important part of our business is that of licensing and organization of local companies for central stations, where the current is furnished to the consumer from a central point, and charged by a meter according to the exact quantity of light consumed, at prices not exceeding the ruling prices of gas, and leaving a profit to the sub-company. This has never been accomplished either electrically or commercially by any other system of electric lighting in the world. In the city of New York, we have 600 customers, using 13,000 lamps all lighted from 1 station, and we have applications from 100 customers more than we are able to supply with our present capacity. That station is now earning a very handsome profit, and has been running day and night for more than 2 years. Very truly yours, F. S. HASTINGS,
Secretary and Treasurer.

The Edison Company for Isolated Lighting,
65 5th Ave., New York, December 17.

[The above information was kindly furnished in response to a request, and we are sure will be of interest to our readers.—EDITOR.]

QUESTIONS AND ANSWERS.

[49.]—**Raising and Lowering Arc Lamps.**—T. D. R., referring to our Chicago letter, page 247, Vol. III, wishes to know if a successful device for this purpose would be a paying investment, also if required in incandescent lighting. **Ans.** This is one of those cases of detail, which even if successfully treated and appreciated would probably not be considered a *valuable* invention. It is unnecessary in incandescent systems.

[50.]—**Battery for Incandescent Lamp.**—I. B. La M., Montreal, asks for information regarding a battery sufficiently strong to operate a small incandescent lamp experimentally. **Ans.** See replies to questions 10 and 11, vol. III, page 67.

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CORRESPONDENCE.

NEW YORK AND VICINITY.

The Tribulations of the Pooling Telegraph Companies.—Anxious Telegraphers.—Journalistic Enterprise.—Subterranean Progress.—Electric Light Competition.—The Commercial Cable Co.—The Manhattan Kiosk Co.—Automatic Protectors Wanted for City Wires.

SINCE the retirement of the Baltimore and Ohio Telegraph Co. from the tri-partite agreement, the Postal and the Bankers and Merchants' companies have been working together in harmony, so far as could be observed by the public. It is generally understood, however, that behind the scenes there have been symptoms of a final rupture ever since the pool was formed. All concerned appear to be in good spirits over the dissolution. It is well known that these separate organizations cannot pay expenses on the basis of the present tariff. It is hardly probable that any solvent company will care to assume the bonded obligations of the Bankers and Merchants' Co., especially during the present commercial depression.

The reported action of the Western Union Telegraph Company in discontinuing its practice of paying extra for overtime, in different parts of the country, has created considerable anxiety in this city, where no such notice was posted. This is believed to be a repetition of the old device to first feel the pulse of the fraternity at distant points, while not admitting at headquarters that there is any truth in the reports. While there is no immediate apprehension of a strike, it being well understood that this is the dull season of the year in the northern states, advantage is being taken of the existing excitement by the operators to perfect an organization which will be ready for any future emergency.

One of those great feats of modern journalism, which can be fairly appreciated only by those familiar with the work, was the publication of the proposed Spanish treaty by the *New York Times*, in advance of its official promulgation through the regular channels. It was telegraphed from Madrid in Spanish, and translated in this city. It contained over 6,000 words upon which the telegraph tolls were $4,400. It is such exhibitions of enterprise as this on the part of a single newspaper, which seem to indicate that journalism has outgrown the antiquated machinery of the Associated Press.

The New York and New Jersey Telephone Co. has inaugurated the subterranean era in Brooklyn, and began work in Joralemon street, December 10th. This company will use the Callender and the Patterson cables. In this city the Edison, Patterson and Brooks systems are to be used, with a view to eventually determining which is practically the best and most economical.

The close competition between the rival electric lighting companies is aptly illustrated by the proposals received for establishing an electric light plant on Ward's Island. The Board of Estimate and Apportionment, granted $15,000 for the purpose. The Edison company's bid was $13,500; the Sawyer-Man company's $14,078, less $500 if certain fuel be supplied for 30 days, and the Brush-Swan company's $13,735. The successful bidder will be compelled to furnish two bonds of $10,000 each, and guarantee the working of the plant for six months. According to the specifications 876 burners will be used on the island. It is expected that better and purer air will be obtained in the hospitals by using electricity instead of gas.

The Commercial Cable Co. has completed the laying of its subterranean connection with the office at 21 Wall street, by drawing a cable through an iron pipe laid under the pavement, from the East River Bridge via Water and Wall streets. Cable telegraphy is a novelty in this city, and the syphon recorder has been placed where it is easily viewed from the sidewalk through the plate-glass front, and the curious may readily satisfy their desire to see the mechanism without violating the secrecy of the establishment. The broken ocean cable was spliced December 19th, and the company opened December 23d for regular business. It has been thoroughly advertised.; has a good business location; a most competent and experienced manager, and will probably secure a fair share of patronage, if the alleged antipathy to Jay Gould has any foundation in fact.

There is considerable curiosity as to the real intentions of the Manhattan Kiosk Co., which is making strenuous efforts to secure from the city authorities, permission to erect newstands or kiosks at various points in the streets. They are to be fitted up with police, fire-alarm and district telegraph communication, and possibly lighted by electricity. Considerable opposition has been awakened by the owners of existing street privileges for various huckstering purposes, and the movement certainly has the outward appearance of what may be as offensive a monopoly on the surface, as the elevated railroad news company is above ground. The scheme has been buried for the present, but will doubtless be resuscitated eventually.

In consequence of the damage to the police telegraph instruments caused from time to time by the crossing of the electric light and the city wires, application has been made by Superintendent Crowley for authority to use some system of automatic protection, which will obviate such difficulties in future.

NEW YORK, Dec. 26, 1884.

NEW ORLEANS.

The World's Industrial and Cotton Centennial Exposition.—The Provisions for Steam Power.—A Glance at Some of the Leading Features.—The Distribution of Time.—The First Telegram from Washington to Baltimore.—How the Machinery Was Not Started by Electricity.—The Opening Ceremonies.

NEW ORLEANS, famous as it is for its holidays and carnivals, has never yet seen such a day as this. Business in general was suspended, public buildings, stores and dwellings profusely decorated, while the people turned out in full to attend the opening of the "greatest exposition the world has ever seen."

Advertised as it has been, everybody knows of its great main building—the largest ever built, its roof covering 33 acres of exhibits from all quarters of the globe. Vast as are these proportions, they have proven entirely inadequate. Forty-five hundred exhibitors cannot all be satisfied. Twice has Machinery Hall (part of the main building) been enlarged by extensions. The Director-General stated to the Board of Management that if they would roof the entire park—247 acres—he could fill it with exhibits in sixty days!

Boilers aggregating 5,200 h. p. are situated a safe distance from the building, and furnish steam through a 30-inch pipe to 22 engines of various sizes, of a total of 4,500 h. p. Of this, 1,600 h. p. are needed to drive the electric plant used in lighting the buildings and grounds. Eleven thousand feet of shafting will drive machines of almost all known kinds. Worthington pumps distribute 3,000,000 gallons of water daily through a comprehensive system of pipes. Fifty-two hydrants are situated judiciously in the main building as a safeguard against fire.

Several systems of electric lighting will be shown conspicuously, contracts having been given the Edison, Brush, Jenney, Thomson-Houston and Leavitt-Mueller companies.

As with all other expositions, the exhibitors are coming in with a rush at the last moment; and although hundreds are ready, much still remains to be done, and probably several weeks will pass before all are installed. When, however, it is taken into consideration that every state and territory in the Union will be represented, and that 27 foreign governments applied for space, it is only to be wondered at that so much is already accomplished. To allow the delinquents a little more time, for a few days the gates will close at 4 P. M. After that the closing hour will usually be 10 o'clock.

Though by no means an electrical exhibition, the electrical features will be most striking. When we recall the Philadelphia Centennial, only eight years ago, and remember that an electric lamp was then almost a curiosity, we are amazed at the wonderful strides made since then. Here everywhere the numerous wires and lamps greet the eyes by day, and at night the vast buildings and extensive grounds will be in a blaze of glory. The great Corliss engine, the object of admiration of all who visited the Centennial, would prove incapable of driving the dynamos alone of this the greatest of all similar enterprises.

An astronomical clock in the main building will be connected electrically with the one in the Naval Observatory in Washington, and its time will be governed to the fraction of a second at noon daily. Time from this clock will be distributed electrically throughout the grounds and buildings. An electric railway is spoken of, but as yet no visible signs of it are apparent.

Among the Maryland contributions to the Exhibition is the first telegram sent from Washington to Baltimore. It was also at the Centennial, and for the benefit of those who have seen or will see it the following anecdote is related: In the spring of 1844, Morse, the inventor of the telegraph, proposed to make the first trial of his invention in a room in the Capitol at Washington. Several gentlemen were present, and when the question arose as to who should send the first message over the wires, one of them proposed that President Tyler should have that honor. No! no! no! was the rejoinder from every quarter. Mrs. Madison, the widow of our illustrious President, was next named. The yeas were then unanimous. She was sent for, and came down to the Capitol shortly afterwards. "Gentlemen," she said, on entering, "I understand you wished for my presence. What is it you expect of me?" Hon. John Wethered (now of Catonsville, Baltimore County), then a Member of Congress, who was present, informed her that she could send a message to Baltimore and receive an answer in 15 minutes. The expression of her face would have made a study for a painter as she rolled up her large blue eyes and said: "Can that be?" The message she sent was to Mrs. John Wethered, wife of ex-Congressman Wethered, and daughter of Philip E. Thomas, the first president and projector of the Baltimore and Ohio Railroad, and was as follows: "I send my love to Mrs. John Wethered."

Great regret was expressed upon all sides at the absence of President Arthur upon this occasion, as it was first expected that he in person would formally open the Exposition and set the engines in motion. However, the novelty of the opening being controlled by the President some 1,200 miles away, in a measure compensated for this disappointment. At the appointed time all available space in and about Music Hall (situated in the centre of

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main building) was filled to its utmost capacity. Upon the orchestral platform were seated the officers and boards of the Exposition, commissioners of the states and foreign governments, the Governor and his staff, the Mayor and city officials of New Orleans, the orchestra and invited guests. Immediately in front was the Mexican band. In a conspicuous position was placed the telegraph instrument in direct communication with the President in Washington, and near it another, in charge of General Burke's little son, in connection with a bell placed upon the cylinder of the largest of the engines in Machinery Hall. The ceremonies were brief but imposing. Upon the appearance of Director-General Burke the air rang with cheers, which were repeated when Colonel Edmund Richardson, president of the Exposition, came forward and presented, by telegraph, the Exposition to President Arthur. The returning signal being received, Master Lyndsey Burke, in the presence of the great audience, repeated it to Consulting-Engineer Gilman, stationed at the engine, who at once opened the valve, and the big wheel commenced to move. Instantly five more engines were started, and hundreds of feet of shafting began their incessant revolutions. At that moment a large picture of President Arthur was swung in full view at the head of the platform, the Exposition was declared open, and, amidst cheers and music, the audience dispersed throughout the buildings and grounds. Thus favorably was this great enterprise inaugurated.

NEW ORLEANS, Dec. 16, 1884.

CHICAGO.

Explosive Subterranean Systems.—The Dorsett Underground Conduit.—Merchants Petitioning for Sidewalk Lighting Permits.—Growth of Electric Lighting During the Past Year.—The Western Union Underground System.—New Fire Alarm Plants.—Telephone Gossip.

A NEW phase in the underground question—the occasional blowing up of the gas in the conduits—seems to complicate, where in all conscience there was sufficient complexity before. It is evident that in large cities, where the "ground hog" ordinances are necessary. this new bugbear is playing mischief. Your Philadelphia correspondent, and since that, personal information from members of the Philadelphia fire department, show conclusively that no underground system which permits of the ingress of gases from the surrounding earth, is safe. The iron pipe in use by some of the telegraph companies in other places besides Philadelphia have proven faulty for similar reasons, and I am told the pipes laid during the summer and autumn of last year, in Chicago, have on more than one occasion blown up, seriously injuring one or more unfortunates who happened to stand in front of the gun.

Prof. J. P. Barrett, in an interview published in the *Tribune* a few days since, highly endorses the Dorsett conduit, and says, having "spent five years examining and testing devices for this purpose I finally recommended the use of the Dorsett system by the city."

The Dorsett system is that which is being laid for the electric light, telegraph and telephone wires, which, as has been previously stated, are all to be "sent below."

The conduit company has broken ground on Lasalle and Washington streets and is working southward at a fair rate of progress. The plan is to place proper "leading in" conveniences 20 to 25 feet apart, so that the wiring of two consecutive buildings can be readily accomplished, and the present system of spider-web or clothes-line decoration along the fronts of buildings be discontinued.

In the matter of lights upon the outside of buildings, there is continued difficulty. The electric light companies—or a portion of them—acting in concert for the first time I think, asked the opinion of corporation counsel Winston, relative to the prohibition of lights outside the building line of stores, etc. His opinion was adverse to the wishes of the gentlemen, and sustained the order, under Sec. 2,022 of the code, which, originally framed to cover the overhead wires of the telephone and telegraph companies, still included "electrical conductors," as among the "tabooed" abominations. So, at the last meeting of the city council a petition from sundry citizens was presented, asking permission to place outside lights at their several places of business. An order was also presented, and its passage asked, which will empower the sup't of city telegraph to grant such permits, subject to such regulations as he may deem proper. Their particular flurry just now is the desire to get lights out for the holiday trade, which seems to need a little extra boosting to bring it up to the average. The above communications were referred to the committee on fire and water—and Christmas is close at hand.

The forthcoming annual report of the electric light inspector to the sup't of city telegraph will show that there has been a very large increase in the number of electric light plants during the year, both arc and incandescent. One life only has been sacrificed in the city, and the peculiar circumstances of that occurence seem to throw a shadow of uncertainty on the cause of the death. Unfortunately the deceased was alone in the engine room at the time, and when found was lying upon his face, at least twelve feet from the back of the dynamo, with a shovel at his side. He had been at work with the shovel just before supper, and finishing before the rest of the employés, had returned to his work, alone. As he was a new man at the business, he had been repeatedly warned of the necessity of the utmost caution in handling the lamps and dynamo, and circumstances show that if he did come to his death by means of a current of electricity, it is quite certain that the accident arose from disregard of the frequent warnings he had received. *Per contra*, between May and November, 12 deaths are recorded from improper handling of gas.

The Western Union Co. has laid a four inch iron pipe from the office, corner of Washington and Lasalle streets to the city limits, at 39th street, in which to hide its wires. Electrician C. H. Summers, could give me no details as to the number, size or insulation of the wires which will be laid in this conduit. Information on these points it is presumed will emanate from headquarters in New York.

Mr. E. B. Chandler, Gen. Western Agent of the Gamewell Fire Alarm Telegraph Co., informs me that business for the past year has been prosperous, many new plants having been placed, and seven of those already in, considerably enlarged. Of the former he mentioned Algiers, La., Racine, Wis., Fargo, Dakota, and the town of Lake, in this county—the last being quite important as an adjunct to our city system, with which it joins territory. Among those extended are Milwaukee, St. Louis, Minneapolis, St. Paul, Oshkosh, Peoria and Denver. A temporary plant has also been placed in the New Orleans exhibition.

Telephone matters are moving along much in the same old way. Much satisfaction is evident among officers and stockholders of the Bell telephone adherents, at the decision in the Bell-Drawbaugh case. Central Union, which previous to the decision was only worth about 40 cents is now on the up grade, and has reached 70 and above. During the past year this stock has paid no dividends, but it is now very generally expected, that sometime in January a regular dividend will be handed to all the faithful, and that extra dividends will subsequently follow, to make up for those which have been passed. The Chicago company goes right along; apparently has known nothing of hard times, and the stockholders say they have no complaints to make on the paying quality of the scrip.

The Overland people are hard at work, but like Joe Bagstock, they are sly. A test was made a few days since between here and Milwaukee, which was said to be highly satisfactory. It looks now as if their promise of an exchange here on the first of January would hardly materialize, but—we shall see.

CHICAGO, Dec. 18, 1884.

SAN FRANCISCO.

The Question of Subterranean Lines.—Electric Lighting Maintained by Private Subscription.—Supposed Prospecting for the Postal Company's Extension.—Gold Medals Awarded in Return for Gratuitous Lighting.—Progress of Electric Lighting on the Coast.—Competing District Companies.—Active Telephone Management.—Reduction of Telegraphic Force.—An Electro-Political Candidate Defeated.

WHETHER our city fathers will force the various companies which operate lines in this city to run them underground is a question of much interest to shareholders and managers. If subterranean wires can be operated without creating unusual difficulties, their advent should be hailed with delight, particularly by the chief operators of the Western Union in this city, where the wet, thick fogs from the Pacific make Morse telegraphy almost impracticable for the time being, and allow very little margin in the box of a duplex. To the Telephone, Gold and Stock, and District companies it would work great pecuniary damage, and to some would be ruin. The Electric Light Co. is now sustained by private subscriptions, and it would be impossible to make it a pecuniary success on the basis of a subterranean plant; but as all flesh is grass, and grass is hay, it will be a new experience if some of the city fathers do not make hay while the electric sun shines, and allow the wires to remain as they are.

James Gamble is here, and his movements are watched with a great deal of suspicion and interest. It is surmised that he is laying plans toward building the Postal lines to the Missouri river, and that for this purpose he has entered into partnership with his brother-in-law and Mr. Booth, of Oakland, under the firm name of Coleman, Gamble & Booth. Whatever truth may be in the rumor remains to be demonstrated, but scarcely a better man could be selected for that purpose, as he knows every inch of this coast, as well as every business man of any prominence here. He would know where poles would have to be set with more than usual care, and other details which a stranger would pass over as trivial. Whether the advent of the Postal will be beneficial or otherwise to the skilled operator, certain it is its completion to this city is hopefully looked forward to by the fraternity.

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At the annual fair held in this city the Brush and the Thomson-Houston companies alternated nights in lighting the pavilion *free*. The Sperry company had also a fine display of incandescent and other lights, for which it received the silver medal, and the other companies gold medals—not on account of superior lights, but because of their liberality. The Thomson-Houston company lights the cities of Oakland, San Jose and Sacramento, and is negotiating for Portland, Oregon, and Los Angeles, while the Brush system seems to have a monopoly of San Francisco, and with a shrewd business man and influential politician like P. B. Cornwall as its president, it would not surprise me to see this city lighted exclusively by that company, and gas superseded; but ere that occurs some of the city fathers will leave office wiser and richer men.

George S. Ladd, the President of the Telephone company, is also President of the Edison Incandescent Light Co., and he is waiting for a favorable moment to demonstrate to our people that his light is much superior to gas. He is at the present moment in excellent humor over the decision in the Bell-Drawbaugh suit, and even Mr. Sabin does not begrudge the various suits of clothes he lost on Blaine.

The Gold and Stock and American District companies, under one management, are almost exclusively owned by the Western Union Telegraph Co. Although the mining stocks do not create as much excitement as they used to do in years gone by, the united companies seem to be doing a good business. As the District company does most of the Western Union city delivery, it is thus enabled to make a better showing than would otherwise be the case, as the San Francisco District Co. is taking a great deal of its business away.

The Telephone company, under the management of Messrs. Ladd and Sabin, has in a measure reduced Western Union local receipts, they having exchanges in every town on the coast, and some of the most prominent are connected direct with San Francisco, where their wires are a net-work. Certain it is that business was never so dull in the San Francisco office as at present, and Mr. Rankin's eye moistens when he is ordered to dispense with four of his best men from the 1st of December. He regrets the necessity, but such events must occur if the telegraph is not properly patronized.

L. N. Jacobs is expected to succeed E. C. Fleming as night chief at the Western Union office, the latter gentleman being seriously ill. Mr. Jacobs received the Republican nomination for County Clerk, but failed to poll the necessary number of votes for election, partially because a third candidate was in the field, and partially because he stood by the Western Union during the strike. For this reason, the labor organizations went against him, and none so bitterly as the operators, who clearly demonstrated that they were more thoroughly organized than in July, 1883.

SAN FRANCISCO, CAL., Dec. 8, 1884.

BOSTON.

The Western Union Subterranean Line.—The American Electrical Exhibition.—Rumored Amalgamation of Electric Light Interests.—Gossip About the Telephone Patent Suits.—New Electric Light Plant.—Proposed Development of Long-distance Telephoning.—Harvard Students on Government Telegraphy.—Introduction of the Weston Incandescent Lamps.—The Western Union Abolition of Over-time.

THE result of the controversy between the city authorities and the Western Union Telegraph Co. relative to poles on Friend street, referred to in my last, resulted in the latter putting down an underground system, extending from the Eastern railroad station through Friend, New Washington, Devonshire and State streets to the Western Union offices. The system is simply iron pipes laid in a trench 2 feet deep with manholes every 450 feet. The cables will be drawn in. The newspaper electricians think that this settles the matter for all electric wires, and hug themselves to think how much they know about such plain and simple matters.

The electrical exhibition, after as many false starts as an agricultural horse trot, has finally opened the ticket office. The first opening was to be Nov. 24—then Dec. 1, afterwards Dec. 3—and it finally opened Dec. 8. The hesitation was owing to the fact that the principal exhibitors had not made up their minds to exhibit when the first opening date was announced. It would have been more attractive if some of the local characters known in the electrical line had been connected with the enterprise. Although the exhibition has been opened ten days the display is not large as yet. The principal exhibits are those of Edison, composed of lamps and his private exhibit; and that of the American Bell Telephone Co. The Arago electric light shows up well, on the outside and inside of the building. The historical collection is small, comprising Western Union and fire alarm models. The Dudley Electric Manufacturing Co. show a system of individual calls for telephone lines, and show it well. Seth W. Fuller exhibits a variety of electrical apparatus, etc. Blodgett Bros. exhibit their railroad time apparatus, etc. The New York Insulated Wire Co. is on hand. The New York Consolidated Electric Light Co. has its dynamo in position and its exhibit is progressing. Ocean telegraphy is graphically illustrated. The Rhode Island Telephone and Electric Co. has its clock system working—as have also the American Watchman's Time Detector Co., the Martin Automatic Fire Alarm Co., the Municipal Signal Co. and Orcutt's Electric Railroad Signal. The Bidwell railway looks well, composed of tracks and cars—the former encircling the gallery. The cars, two in number, are built with open sides; the first car carries the driver in front where the apparatus is located. The power is obtained from a Weston dynamo on Stanhope street, some distance from the building. The cars are lighted by electricity from the rails. The incubator man is here with his "electrical" exhibit. The "Orne" battery has a show case. Prof. Dolbear has his box on the main floor and illustrates his telephonic system; he has a Reis transmitter connected with it, to show that the Reis instrument *can* be made to talk, notwithstanding the sneers of an unbelieving world.

There are rumors of consolidation in electric light circles, in this city. The three companies—American, New England Weston and Brush have been engaged in a ruinous competition, and while not exactly losing money are not paying dividends. The consolidated stock appears to be an obstacle; as each company has a reasonable capital now; to consolidate to make money, means to squeeze somebody.

It is the world's news now, that the Drawbaugh claimant has gone to join the long line of which the Tichborne claimant is a shining example. The news of Judge Wallace's decision was first received at the American Bell Telephone office, in this city, and over their telephone line from New York—the brokers getting their information later by private wires. The stock of the company sold in the morning stock board at 220 and 215—but, after the brokers had picked the lambs clean, the stock shot up to 275—and holders expected to realize at 300, but the public did not come in with that tumultuous rush of former years, so there was a sag. The announcement by the company of a special dividend of 3 per cent. for holders to put in their Christmas stocking, sent it up again, but the first wave was the highest. The result was of course very gratifying to those who were fortunate holders of the stock; there were many, however, who *intended* to participate, but had not nerve enough to jump in. The Overland Telephone case, suspended last January in Philadelphia, will now be the next thing to settle; the judges in that case holding off, it will be remembered, to hear the decision in the case now decided, as the Drawbaugh evidence was introduced by the Overland people. Of course the Overland case was practically decided when Judge Wallace sat down so hard on Dan. With the Drawbaugh and Overland companies enjoined, the telephone field will be comparatively clear; whether the Baltimore and Ohio telegraph people, who are sponsors for the Meucci first-inventor-claimant will make a stand remains to be seen. The recent decision would seem to be a wet blanket to claimants whatever their pretensions; and the Meucci-man who evidently thought he could speak numberless miles through a hollow tube, using a battery and key for signaling, will not use up the "monopoly" very thoroughly.

A company has closed a contract with the American Electric and Illuminating Co. of this city, for the immediate installation of a complete 100 arc light plant, with accompanying machinery for incandescent lights and motors. Real estate is to be purchased and construction commenced immediately.

The statement comes from a director of the Bell company that among the enterprises to be pushed by the company is the long-distance talking business, and that soon New York and Philadelphia, and eventually New York and Chicago, will be connected, using the hard-drawn copper wire, such as now connects New York and Boston. Connections are to be made with subscribers by means of private switch-boards without the intervention of the central office.

The telegraphs of the country will surely not pass under the control of the U. S. government now, as the Harvard College students in the debate in the Harvard Union the other evening, settled that point and clinched it down hard by a vote of the members.

The New England Weston Electric Light Co. is now putting in the new large incandescent lamps of 125 candle power, along the line of available circuits. The light is very steady, pleasant to the eye, and is free from the disadvantages of the arc system, especially for interior illumination. Small lights of 16 candle power can be run from the same circuit.

The Western Union telegraph operators have been notified that hereafter they will be deprived of their "extra." This order reduces salaries in some cases $30 and $50 per month.

BOSTON, Dec. 18, 1884.

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PHILADELPHIA.

Too Many Subterranean Enterprises.—Financial Embarrassment of the Sectional Conduit Co.—Referee's Decision on the Question of the Telegraph-Pole Tax.—Underground Privileges Granted.—

THE chief topic among electricians in this city is the "underground" problem. As there are some half-dozen different systems here—all claiming to be the best—it is a difficult matter to see where they all propose to make money out of their enterprises. To be a little more forcible than elegant, "somebody is going to get left." The embarrassments of the Philadelphia Sectional Electric Underground Co. seem to be on the increase. In my last letter to THE ELECTRICIAN AND ELECTRICAL ENGINEER I spoke of the trouble this company has been having in the shape of explosions that have occurred in their trenches, caused by the accumulation of foul air and gas. *Now* a new difficulty has been sprung on them, inasmuch as a judgment has been taken out against the concern for non-payment of a promissory note, amounting to $5,669.12, with interest. The most important piece of property belonging to the concern is said to be the conduit which extends from Third to Broad streets on Chestnut, with a branch to the Public Buildings, and another down Eleventh street a short distance. This conduit has been leased to and is now operated by the Electric Light and Power Co., which corporation is said to be controlled by men largely interested in the Underground company. The Councils have granted to the Underground company the right to lay conduits on Chestnut street, and this franchise is regarded as one of the most valuable assets of the company. The conduit and city franchise are estimated to be worth much more than the amount of the iron firm's claim, and it is intimated that the matter will be arranged before it comes to a sale.

The decision of the referee in the suits brought by the city against the Mutual Union, the Western Union and the Bell Telephone companies, who yesterday filed his report in the Court of Common Pleas, is of considerable importance. The claim was contested by the companies on the ground that it was exorbitant, and the referee, in his opinion, sustains this view of the matter strongly.

The city sued to recover an aggregate of $6,885, which, it was claimed, was due and owing by these companies for licenses for the year 1883 upon poles and wires, as provided in ordinances of January 6, 1881, and March 30, 1883. The entire amount claimed from all the companies for tax on poles and wires was $14,208, of which $9,500 was for the former and $4,658 for the latter uses If the referee's judgment is approved by the court, and the case is allowed to rest, a loss of $11,708 annually would result to the city from this source. The referee thinks $3,500 a reasonable charge. Superintendent Walker, of the electrical department, said this afternoon that the subject was purely a legal one now, and that if the tax is not proper Councils will be compelled to frame a new ordinance. "It is immaterial to me," the superintendent said, "what shall be charged, as I am required only to enforce the ordinances referring to my department. I can tell you, though, that the pole tax here is a dollar, while in other cities it is higher, being in Baltimore $2 per pole."

Superintendent Walker yesterday told the chairman of Councils Electrical Committee that the various companies owning overhead wires, who had been notified as to the penalty of a non-compliance of the ordinance requiring them to be placed underground, had informed him that the penalty would be paid under protest. The referee to whom the question of the legality of the ordinance was referred decided that as the penalty was in the nature of a tax upon the companies, Councils had no authority to levy it.

The committee considered favorably the ordinance granting the Baxter Overland Telegraph and Telephone Co. permission to lay a cable in certain streets from Point Breeze to Germantown. An amendment to the ordinance provides that the entire circuit of the cable be completed within one year from the date of the granting of the privilege. The ordinance granting permission to the Morse Underground Co. to lay its conduits in the streets was reported negatively, the representatives of the company having failed to appear before the committee.

PHILADELPHIA, Dec. 19, 1884.

WASHINGTON.

No Government Telegraph Legislation this Winter.—Underground Electric Light System.—Telephone Affairs.—Prospective Reopening of the Postal Office. —The New Baltimore and Ohio Building.—The War on Overhead Lines.

ALTHOUGH Congress has not formally taken a recess, it is as certain there will be no legislation before the 5th of January as if the usual adjournment over the holidays had taken place. Thus two-fifths of the session has gone and nothing has been done regarding the control of the telegraph by the government, unless it be in the nature of taking nought from nothing, for by the action of the Senate caucus on the order of business, so many other matters were put to the front that the bill of Senator Hill was left so far in the rear that it cannot hope to see daylight in the eight remaining weeks of the session. Senator Hill has consequently given up the effort, and has been looking to the House for something on which an effort for action in the Senate could be based. This being the situation of affairs, Mr. Money, chairman of the Committee on Post-offices and Post-roads of the House, has diligently sought to get a day assigned for the consideration of his bill, which proposes contracts by the government for a term of years for telegraphic service; but the obstacles have thus far been insurmountable, and as the time for final adjournment draws nearer the difficulties will increase. As I understand the case, the advocates of a *bona fide* government control of the telegraph are not satisfied with the bill of Mr. Money, and charge that it is inspired by the companies, while the companies do not desire it, but would prefer it to the threatened more radical legislation. They would prefer to be "let alone," and as there is therefore no powerful influence behind this measure it is not likely to make headway. Mr. Anderson, the author of one of the bills for a government telegraph, says the old companies would sooner have the Money bill for ten years than risk the future in Congress. There will be some speeches on the subject even if the bill does not come up. These will probably be made on the post-office appropriation bill when it comes up, or they may go into the *Record* on "leave to print," but there will be no legislation on the telegraph by this Congress.

The United States Electric Light Co. has completed its underground wires for lighting F street from 9th to 14th street, and has supplied the light for the past two or three weeks. The laying of the wires was quite expensive, as the concrete pavement had to be cut up, but the business men on the street generously contributed a sufficient sum to make up the difference, and the street is now beautifully illuminated. The lamps are placed on posts about 10 feet high at short intervals along the curb, the wires running up inside from beneath the ground, and are not visible. A further extension of this mode of street lighting is contemplated by this company. They already have a number of subscription lamps in front of business places on Pennsylvania avenue, which in some localities make this broad avenue quite brilliant. This company has an energetic management, and seems to be doing a good business. A semi-annual dividend of 4 per cent. was made on the 1st of July, and a like dividend has been ordered, payable January 1st. I am assured these are made from the net earnings, and that a handsome surplus remains in the hands of the treasurer. The company is now engaged in putting in 160 incandescent lamps in the printing office attached to the Treasury department and located in the Treasury building. This work is being done under the superintendence of Mr. Charles F. Burns, of the New York office. It will be completed soon after the holidays.

The Chesapeake and Potomac Telephone Co., a consolidation of the Washington, Baltimore and Maryland systems, has declared its usual semi-annual dividend. Under General Manager S. M. Bryan the telephone is regaining the popularity which was so badly shattered under the former management, when a purely local enterprise

W. F. Allen, late local manager of the Postal company, is here to reopen an office, and is looking up the old employés of the office. It will require some time for the two smaller companies to regain the footing they had gained before the attempt at consolidation.

The new railroad and telegraph office of the Baltimore and Ohio company was rapidly run up to the third story, when the cold weather put a stop to the work. The structure when completed will be quite imposing, and have a strong tendency to preserve the popularity of the old telegraph corner, despite the gradual movement of the business centre westward. In this connection it may not be uninteresting to state that 30 years ago all the telegraph offices—Morse, House and Bain—were located (and centrally, too) east of 6th street, with a single branch office in Willard's Hotel.

The war on overhead wires continues. No efforts have been made to compel those up to come down beyond refusing to permit new poles where the old ones are rotting away; but no new lines are permitted. An effort is being made to get the question into the courts, in order that its legal status and the powers of the commissioners and the rights of the corporations under the law may be judicially determined. The last utterances by the authorities were made on Wednesday by Commissioner Edmonds, who said that if citizens would examine the matter they would not complain of poles erected in the alleys. "The commissioners," he said, "have forced the telephone and telegraph companies to begin placing their wire underground in the streets. They leave the streets free, and we let them erect a distributing pole in the alleys. It would be impossible for them to go underground in the alleys, as they would have to dig up the citizens' property in order to furnish each patron in the square. As it is now, they run a distributing wire in the alley, and connect all the patrons, and that is a great deal better than having the streets burdened by the wires.

WASHINGTON, D. C., Dec. 20, 1884.

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ELECTRICAL NEWS AND NOTES.

OPINION OF JUDGE WALLACE IN THE TELEPHONE CASE.

DECEMBER 1, 1884.

STATEMENT OF THE CASE.

This suit is brought to enjoin the defendants from using and furnishing to others for use the several inventions described in two patents granted to Alexander Graham Bell, of Salem, Massachusetts, being No. 174,465, bearing date March 7, 1876, for "Improvements in Telegraphy," and No. 186,787, bearing date Jan. 30, 1877, for "Improvements in Electric Telephony." The issues made by the pleadings are practically resolved into the single question, to which the proofs and arguments of counsel are mainly addressed, whether the patentee Bell, or Daniel Drawbaugh, of Milltown, in Cumberland County, Pennsylvania, was the first inventor of the electric speaking telephone.

Concededly Bell was an original inventor of the telephone, the principle of which with the essential means for its application, are described in his first patent, and of the improved apparatus described in his second patent. The fifth claim of the first patent is for "the method of and apparatus for transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds substantially as set forth." This patent has been judicially construed in two cases in the Massachusetts Circuit; and in both cases it was substantially held that Bell was the discoverer of the new art of transmitting speech by electricity, and that the claim should receive the broadest interpretation to secure to the inventor not the abstract right of sending sounds by telegraph without regard to means, but all means and processes described which are essential to the application of the principle. American Bell Telephone Co. *vs.* Spencer, 8 Fed. Rep., 509. Same *v.* Dolbear, 5 Fed. Rep., 448.

In view of the conclusion reached upon the merits of the issue, it is not material whether Bell's inceptive invention did or did not antedate the time of filing his application for the first patent. That application was filed Feb. 14, 1876 It describes apparatus which was an articulating telephone, whether Bell knew it or not. Mr. Cross, an expert, caused apparatus to be made in conformity to the description and to drawings as shown in figure 7 of the patent, which proved itself to be an operative, practical telephone. Probably the date of his inceptive invention might be carried back to July, 1875, but, irrespective of the time of the invention, the justice of his claim to be an original inventor of the telephone must remain unchallenged. It was through him also that the telephone was made known to the scientific public, and thence introduced into commercial use.

THE DEFENDANTS' ANSWER.

The defendants contend that, long before Bell had perfected his invention, and long before its mental conception by him, Drawbaugh had not only made the same invention, but had perfected improvements in organization and detail which Bell never reached, and which were only reached years afterwards by the work of many other inventors in the same field of improvement. Their theory of the facts is stated with substantial accuracy in the answer to the bill of complaint. The answer, among other things, avers that Drawbaugh "was and is the original and first "inventor and discoverer of the art of communicating articulate "speech between distant places by voltaic and magneto electric-"ity, and of the construction and operation of machines and in-"struments for carrying such art into practice; . . that the "said electric speaking telephones so constructed and success-"fully and practically used by him contained all the material "and substantial parts and inventions patented" in the two patents granted to Bell; and also contained other important and valuable inventions in electric and magneto telegraphy; . . "that some of the original machines and instruments invented, "made, used and exhibited to many others long prior to the "alleged inventions of Bell are still in existence, and capable of "successful practical operation and use, and are identified by a "large number of persons who personally tested and used and "know of their practical operation and use in the years 1870, "1871, 1872, 1873, 1874, and both subsequently and prior there-"to; . . that said Drawbaugh for more than ten years prior "to 1880 was miserably poor, in debt, with a large and helpless "family dependent upon his daily labor for support, and was "from such cause alone utterly unable to patent his said inven-"tion or caveat it, or manufacture and introduce it upon the "market; and that said Drawbaugh never abandoned nor "acknowledged the claims of any other person thereto, but al-"ways persisted in his claim to it, and intended to patent it as "soon as he could obtain the necessary pecuniary means there-"for."

DRAWBAUGH'S STORY OF HIS INVENTION.

Drawbaugh, in his testimony, adopts the statements of the answer as true. He also testifies that he commenced his experiments with the electric telephone as early as 1866; that prior to or as early as in 1867 he had made apparatus (in which he employed a teacup as the transmitter) through which speech could be transmitted feebly and incoherently; and that as early as the time of the birth of his son Charles he had so progressed that his wife, who was then confined to her bed, could, by listening with one of his instruments, hear the words spoken by him in the other instrument in a distant part of the house. His son Charles was born in 1870, and, if Drawbaugh's narrative is true, he had succeeded at that time in transmitting speech distinctly through the instruments, although whispered words would not be accurately heard. He describes instruments which, he says, were made by him from time to time, as experiments which led him from one movement to another. He testifies that he thinks he made his first telephone apparatus prior to November, 1866, and is positive he had it before he moved his shop to the "Clover-Mill," in 1867.

As he describes it, the body of the transmitter was a porcelain teacup, the diaphragm was of membrane, the electrodes interposed in the circuit were two copper discs, the upper one of which was connected to the diaphragm by a wire, so as to vary its pressure upon a low conductor of fine earth or pulverized charcoal interposed between the discs through the action of the sound waves upon the diaphragm; and the receiver was a tin can without a top or bottom, having a membrane diaphragm stretched over one end, connected by a tense cord to an armature supported on a spring, and arranged close to the poles of an electro magnet in the electric circuit. He testifies that subsequently he constructed apparatus upon the same general principle, with some change of detail; and he produces Exhibits "F" and "B," —the former a transmitter and the latter a receiver—as the remnants of the original instruments. Exhibit "F" is a glass tumbler; and he states that at first he used a membrane diaphragm over it, and then one of thin metal; and that for the conductor he used pulverized carbon or carbon mixed with bronze powder, and used various tops or mouthpieces to speak into it. The Exhibit "B," he says, was the receiver; and in this he had discarded the string and the spring of his earlier receiver. He says that experiment led him to improve the transmitter "F" by substituting a metal diaphragm in place of membrane, and he produces a sketch. A reproduction of this instrument has been made by him for use in the proofs, which is designated as "Exhibit F reproduced." In this the mouthpiece is modified in size and in distance from the diaphragm.

He made, according to his testimony, a new receiver of more perfect construction, and produces the remnant of the original, which is designated as "Exhibit C." As he describes the instrument, it was a decided advance upon the former receiver. In using this, he says he tested it also as a transmitter with some success, and then improved it by placing a permanent magnet against the heel of the electro magnet, and thus made a magneto telephone. A reproduction of such an instrument as he describes is made and referred to in the proofs as "Exhibit Reproduced C." After Exhibit "C," he produces Exhibits "I," "A," "E" and "D," as likewise original instruments, made respectively in the chronological order of their production as exhibits. He states that "I" was used by him as a companion instrument to "C." Exhibit "A" discloses a modification of form and a higher degree of mechanical adaptation.

The last two, "D" and E," are concededly perfect, practical instruments; and, according to the testimony of Mr. Benjamin, an expert witness for the defendants, would compete successfully for public patronage with any magneto telephone which had been introduced into use in 1882. It is asserted of these instruments by counsel that no higher development of the magneto telephone has been reached at the present time than is indicated by Exhibits "E" and "D." Drawbaugh does not attempt to fix the time at which he made any of these instruments, or even the year. He testifies, however, that he made all of them prior to the time the "Axle Company" commenced business, which was in December, 1874, except "E" and "D," which were made about that time.

THEORY OF THE DEFENCE.

The theory of the defendants is, that Exhibits "F" and "B" were used by Drawbaugh in 1867, 1868 and 1869, Exhibit "C" in 1869 and 1870, Exhibit "I" in 1870 and 1871, Exhibit "A" in 1873 and 1874; and that Exhibits "E" and "D" were made in January or February, 1875, although cruder instruments essentially similar were made somewhat earlier. It is in proof that 33 patents were granted for improvements in telephones in 1878, 64 in 1879, more than 100 in 1880, and 94 in the first 6 months of 1881. According to the theory of the defendants, therefore, as early as February, 1875, Drawbaugh had not only distanced Bell in the race of invention, but also Gray and Edison, and had accomplished practically all that has since been done by a host of other inventors.

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The case for the defendants must stand or fall by this theory. The proofs leave no room for fair doubt that defendants contention is substantially true, or that the defence has no foundation in fact. It is either true that Drawbaugh had long been treading his solitary path of investigation and experiment in poverty and obscurity, but had perfected his work when the inventions of other explorers were in embryo, or his story is an ingenious fabrication. And, as will hereafter appear, if the defence is a fabrication, many disinterested witnesses have contributed innocently to give it color and strength; but Drawbaugh has deliberately falsified the facts.

POSITION OF THE COMPLAINANT.

The complainant starts with the benefit of the presumption of law that Bell, the patentee, was the inventor of that for which the Letters Patent were granted him. Whoever alleges the contrary must assume the burden of proof. Evidence of doubtful probative force will not overthrow the presumption of novelty and originality arising from the grant of Letters Patent for an invention.

It has been frequently held that the defence of want of novelty or originality must be made out by proof so clear and satisfactory as to remove all reasonable doubt. Washburn *v.* Gould, 3 Story, 227; Smith *v.* Fay, 6 Fish, 446; Hawes *v.* Antisel, 2 B. & A., 10; Patterson *v.* Duffy, 20 Fed. Rep , 641; Wood *v.* Cleveland Rolling Mill Co., 4 Fish, 560; Parham *v.* American Button Hole Co., do., 482. In U. S. Stamping Co. *v.* Jarrett, 18 Blatch., 469; Blatchford, J., said the defendant had not fulfilled "the necessary obligation of showing beyond any reasonable doubt" that Weber (the alleged prior inventor) was prior to Heath (the patentee). In Coffin *v.* Ogden, 18 Wall., 129, Mr. Justice Swayne delivering the opinion of the Court, stated the rule applicable to the defendant as follows: "The burden of proof rests upon him, and every reasonable doubt should be resolved against him."

To overthrow this presumption and disprove that Bell was the first inventor, the defendants introduce the testimony of nearly 200 witnesses tending to prove the priority of invention by Drawbaugh. As the complainant concedes that Exhibits "E" and "D" are highly organized, practical telephone instruments, and fully capable of perfect articulation, the patents are invalidated if these instruments were in existence at the date of Bell's invention; and, as will hereafter appear, either they were in existence as early as in 1875, or it is incredible that they existed at all until long after Bell's first patent had been granted, and his invention had attracted general public attention at the Centennial Exposition and elsewhere.

In the argument for the defendants, great stress is placed upon the evidence of a gradual and natural development of Drawbaugh's invention shown by the original instruments produced, beginning with Exhibit "B," and ending with the perfect magnetos "E" and "D"

It is strenuously urged that these exhibits fortify his testimony describing the instruments no longer extant, and mark the origin and culmination, beginning with the cup machine and Exhibit "F" of two separate lines of invention; one leading to the battery telephone, in which the undulatory vibrations are controlled by variations in the resistance of the circuit; and the other to the magneto telephone, in which the vibrations are created in the act of producing the current itself.

SUMMARY OF DEFENDANTS' TESTIMONY.

The general theory of the defence is substantiated by three classes of witnesses: those who heard of the existence of Drawbaugh's "talking machines" at various times; those who talked through the machines on various occasions, or heard others talk through them; and those who attempt to identify one or more of the exhibits as the instruments they saw used. Only an outline of their testimony will be given.

More than fifty witnesses testify to having heard of the talking machines prior to Feb. 14, 1879.

Of these witnesses, 3 think they heard of them in 1869; 3 in 1870; 2 in 1871; 5 in 1872; 3 in 1873; 3 prior to 1873; 8 in 1874; 2 in 1875; from 1866 to 1876, 1; from 1868 to 1871, 1; from 1868 to 1873, 1; from 1869 to 1870, 1; from 1869 to 1876, 1; from 1871 to 1872, 2; from 1872 to 1873, 1; from 1873 to 1874, 1; from 1873 to 1875, 3; from 1874 to 1875, 1; from 1874 to 1876, 1; from 1872 to 1876, 1; prior to 1869, 1; prior to 1872, 2; prior to 1875, 1.

Sixty witnesses do not attempt to identify any particular instrument, but testify that they saw a talking machine or talked through it, or heard it talked through at Drawbaugh's shop on occasions subsequent to 1867, and most of them fix the occasion as prior to 1876. The substance of the testimony of some of them will be given.

Wilson G. Fox testified that he saw the talking machine at Mr. Drawbaugh's shop about the year 1867 or 1868, when the old Faucet company was in operation there. Prior to March, 1871, the witness was employed in the carding room of the Harrisburg Cotton Mill, and Drawbaugh came there to get material to wrap his wire to use for the talking machine. Henry Bonholtzer testified that he was at Drawbaugh's shop in 1869, and saw talking machines there. Margaret Brenneman testified that she saw the talking machines at Drawbaugh's shop in 1869. Abraham May testified that he did work on Daniel Hart's house at Milltown in August and September, 1870, of which he produces his account books; that he never did any work for Daniel Hart after that; that while doing that work he was at Drawbaugh's shop to get a boring machine mended, which he was using in the work, and Drawbaugh showed him his talking machines, and talked through them from one floor of the shop to another. The witness understood and heard through the machine the words that Mr. Drawbaugh spoke into it. His testimony is corroborated by Jacob H. Kilmore, William H. Martin, and John A. Smith.

Cyrus Orris testified that he saw Drawbaugh's talking machines at different times, from about the 1st of April, 1871, down to 1880, and took his son-in-law, Jacob E. Smith, to Drawbaugh's shop to see the machines about April 1, 1871. Benjamin K. Goodyear testified that in 1871 he seized the personal property of George W. Kissinger, of Milltown, upon an execution issued Nov. 13, 1871; that on Dec. 4, 1871, the attached property was appraised, and on that day witness went to the workshop of Daniel Drawbaugh to find J. B. Drawbaugh, to summon him as an appraiser, and had to wait for him there a short time; that while waiting there Daniel Drawbaugh showed him his talking machines, and talked through them to him, and witness heard him speak, and understood distinctly the words that he spoke through the instrument; and that he was never in Drawbaugh's shop afterwards, so far as he can recollect.

George Natcher testifies that he lived at Milltown in 1871-1872, and never has been in the town since Aug. 9, 1872; that while living there he was at Drawbaugh's shop, and saw and talked through the talking machines on different floors, and listened at the same machine and understood what was said through it. Mrs. B. B. Spangler, a sister of George Natcher, testifies that she moved away from Milltown in 1872, and never has been there since; that she talked into Drawbaugh's talking machines while she lived there; and that she was so small that Harman Drawbaugh had to lift her up to enable her to talk into the machine. Mrs. Mary Free testifies that she was with her sister, Mrs. Lydia Drawbaugh, at Drawbaugh's shop, in September, 1872, when he talked through the machines to them, and she remembers hearing through the machines, "Good afternoon, ladies!" Drawbaugh told them that the machines operated by electricity.

Mrs. Lydia Drawbaugh testifies that she saw the talking machines in September, 1872, her sister, Mrs. George Free, being present. David M. Ditlow testifies that he saw Drawbaugh's talking machines about 1872, when Drawbaugh talked through it, and witness heard and understood through the machine what he said. David K. Ernest testifies that he was at Drawbaugh's shop with John B. Bloser about the middle of June, 1872, and talked with Drawbaugh about the talking machines, and thinks he saw them at that time. This testimony is corroborated by John Bloser. N. W. Kahney testifies that he saw the talking machines about 1872. William H. Martin testified that he was at Milltown with John Keefauver, to get George Hosler to make him a pair of boots. Hosler lived at Milltown only from March, 1872, to March, 1873. At that time witness and Mr. Keefauver went down to Drawbaugh's shop, and talked through the talking machine, from the basement to the attic, and heard and understood what was said through the machines. They talked and listened at the same instrument.

John F Keefauver corroborates Mr. Martin, and also states that he talked through Drawbaugh's talking machine with Jacob M. Sadler, in April, 1873, prior to the death of George B. Hick, and that about two or three years before he saw the talking machines he had heard a good deal about them, and first heard of them at a place seven miles west of Carlisle. Wm. W. Snyder testifies that he was at Drawbaugh's shop on Wednesday, Feb. 5, 1873, and saw the talking machines. He verifies the date by an entry in his diary. Jacob Barber testifies that he was a candidate for the office of County Commissioner of Cumberland County in the summer of 1873, and, in connection with his canvass, went to Drawbaugh's shortly after the death of George B. Hick. While at Drawbaugh's shop he saw the talking machine, and was never in the shop after July or August, 1873.

Ezekiel Worley testifies that about the year 1873 he saw the talking machine at Drawbaugh's shop. His statement is corroborated by John K. Taylor. Abraham Ditlow testifies that he knew of Drawbaugh's talking machine in 1874, and saw it and talked through it at that time. He had forgotten the fact, but was reminded of it by Mr. Alexander Milner, of Porter County, Ind., whom witness told about it in May or June, 1876, in Indiana. William Eppley testifies that he visited Drawbaugh's shop for the last time in May or June, 1875; that he was there several times during the two years preceding that period, and had seen talking machines. Jonathan Fry testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Frederick in the winter of 1875-6, and saw the talking machines there. Jacob Evans testifies that he was at Drawbaugh's shop with his wife, his brother Andrew, and his sisters Margaret and Sarah, about Dec. 1, 1875, and saw and talked through the talking machines.

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Henry L. Hamme testifies that he was at Drawbaugh's shop either in the last of January or the beginning of February, 1876, in company with George Frederick and Jonathan Fry, and saw and talked through the talking machine at the time; that he heard and understood very plainly what was said through the machines, even when Mr. Drawbaugh talked in a whisper. George Frederick testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Fry in January or February, 1876, and saw the talking machine. S. S. Rupp testifies that he was at Drawbaugh's shop with Mr. Hammacher and his scholars on Feb. 1,1876, and recollects that Mr. Drawbaugh at that time spoke about a machine that he had which he called a talking machine, but the witness was interested in other things and did not pay much attention to it. George H. Bowman testifies that he saw talking machines in Drawbaugh's shop in February, 1876, at which time somebody was talking to Mr. Drawbaugh through them. Charles L. Drawbaugh testifies that he saw and talked through the talking machines at Drawbaugh's shop a year or more prior to May 1, 1876, and heard and understood what was said.

The third class of witnesses are those who identify more or less positively one or more of the several exhibits as the instruments used by them, or which they saw used by others prior to March 7, 1876. Exhibits "F" and "B" are identified by the following witnesses: Brooks saw them in 1874; Smyser, in 1872; Eberly, before December, 1870; Wagner, in the fall of 1874; Freese, in 1869 or 1870; Yetter, about Christmas, 1875; Fry, spring of 1875; Carl, in 1870; Scherick, in 1869; Balsley, between 1870 and 1874; Good, before 1872; Kahney, in 1871 or 1872; Schettel, about 1872; Nichols, in 1875; Renneher, in May, 1875; Weber, late in 1874; Stephen, before 1875; Shireman, about 1872; Hawn, about 1872; H. B. Eberly, in May, 1873; J. C. Smith, between April, 1872, and April, 1873; Sternberger, in October, 1871; Fettrow, in April, 1876; Halsinger, prior to 1876; Shoop, in 1869; H. F. Drawbaugh, in 1872; Zimmerman, in 1871; Bates, in 1874; Guistweit, in July, 1870; Hale, in fall of 1873; Stone, in June, 1871; Free, in June, 1872; J. A. Oyster, in June, 1875; Harmon K. Drawbaugh, in January, 1871; J. B. Drawbaugh, in 1869; G. W. Drawbaugh, in 1870; Lenseman, in July, 1871; Fisher, in 1868 or 1869; Hubler, in fall of 1873; Updegraff, in 1874; W. H. Decker, in 1873; and a number of other witnesses saw one of these two exhibits.

The identification of Exhibits "C," "I" and "A" is made by a smaller number of witnesses. Some of them think they saw "C" in 1870, and others at various dates after that and as late as March, 1876.

One of the witnesses thinks he saw "I" in 1871, the others locate the occasions in 1873, 1874 and 1875. Some of the witnesses think they saw "A" as early as 1872, one of them in 1870; but most of them saw it, they think, in 1875.

Exhibits "E" and "D" resemble each other very closely in appearance, and most of the witnesses produced to identify them saw both at the same time. They locate the time as follows: Fry, laborer, in May or June, 1875; Fry, farmer, in April, 1875; Bayler, in June, 1873 (Exhibit "D"); Springer, after April, 1876; Shettel, about 1875; Shoop, after February, 1877; Musser, in June, 1876 (Exhibit "D"); Millard, in 1875; Holsinger, in summer of 1875; Shoop, in 1874 or 1875; Bates, between 1874 and 1877; Dellinger, in March, 1876 (Exhibit "E"); Guistweit, between 1870 and 1876; Bowen, in September, 1878; Hale, in fall of 1875 (Exhibit "D"); Michael Dillinger, in November, 1877 (Exhibit D"); Harmon K. Drawbaugh, in January, 1875, and helped put up wire for them; J B. Drawbaugh, prior to Jan. 26, 1875; George W. Drawbaugh identifies all the exhibits as seen by him some time between 1871 and 1878; Updegraff & Musser, in 1876; Smith, in 1872 or 1876 (Exhibit "E"); May, in 1876 (Exhibit "D"); J. H. Smith, in May, 1876 (Exhibit "D"); Decker, in 1874 (Exhibit "D"); Vannasdale, in February, 1875; Evans, in fall of 1875; Mrs. Erb, in fall of 1875; S. E. Evans, in fall of 1875 (Exhibit "D"); M. E. Evans, in fall of 1875 (Exhibit "D").

Some of the witnesses who identify exhibits identify the whole series. Other witnesses besides those named identify one or more of the exhibits as seen by them at times subsequent to the date of Bell's application for his patent. Some of the witnesses who identify one or more of the instruments exhibited to them by Drawbaugh as the Exhibits "F," "B" or "C" saw or used them in 1875 or 1876. Among these are the following, to whose testimony a reference will be made:—

Mr. Springer testifies that he repeatedly talked and listened with Drawbaugh through the instruments after the 1st of April, 1876, using Exhibits "F" and "B" as the instruments. Mr. Musser testifies that he talked through "F" and "B" in June, 1874; but the proofs show that this occasion was as late as in the summer of 1876. Mr. Moore, who is produced to show that Drawbaugh applied to him to acquire an interest in the invention, testifies that the talking machine which Drawbaugh produced was Exhibit "B." This was in May, 1875. Mr. Bayler testifies that he talked through "F" and "B" in 1873; but the proofs show that the occasion was between 1875 and 1877. Mr. Nichols locates the middle of January, 1875, as the time when he saw Exhibit "B" in use.

DRAWBAUGH'S TALKING MACHINES WERE ELECTRIC.

That the talking machines referred to by the witnesses were electric instruments is clearly established. Drawbaugh testifies explicitly that they were always used with a closed circuit, and without breaking the current, some of them being battery telephones and some magneto telephones. He always represented them as actuated by electricity to those to whom he explained or described them, and claimed his invention would supersede the telegraph. His assertions show them to have been electrical instruments.

He stated to the witness Shank "it was the greatest invention ever known. If he had the means to go on with it, they could talk, or rather be a time to come as to talk, to the old country, same as we can talk here." To Zacharias, that "he could run it out for miles, and parties could talk in at one end and be heard at the other end, the same as persons in a room together." To Smith, that "parties between Harrisburg and Philadelphia could communicate as if they were speaking together; there would hardly be any limits;" it was an "instrument to convey the voice, to supply the place of the telegraph;" to Smyser, that it would work "from here to California;" to Fry, that one "can talk as far as the wire goes;" to Carl, that "he could hear a man talk from that place to New Cumberland or Harrisburg, and understand distinctly what he said;" to Sherwick, that it was "better and handier than the telegraph; that you could just talk through it in place of writing;" to Balsley, that "by attaching two wires you can hear it away off; the telegraph is nowhere with it;" to Kahney, that "he could talk the same for miles as he could for a short distance;" to Shettel, that, "if he had a wire from the shop in connection wlth the telegraph wires at White Hill, he could talk to Mechanicsburg by having a machine there or an instrument in the office; that it would be better than telegraphing, and that it would be worth a great deal of money;" to Reneker, that "he thought he could make it that he could talk through to Harrisburg; he thought they would take the place of telegraphing;" to Weber, that "it beats all the others of my inventions; he could carry sound, or rather talk, as far as Shiremanstown;" to Hawn, that "he would be able to operate that a man preaching in New York, that a congregation in Philadelphia would hear the same sermon;" to Kahney, that "he could just as easy speak ten miles as one, or any distance he would choose to;" to Rupp, who was there with Hamacher, that "it was worked by electricity, would take the place of the telegraph, and that he could make it so that he could talk to San Francisco;" to Musser, that "he was going to make a machine to talk from Harrisburg to Philadelphia, and it would be cheaper and quicker way than telegraphing;" to Smith, that "he believed they could talk for a hundred miles;" to Fettrow, that "I could speak ten, fifteen or twenty miles, or even to California, if there was a wire extended;" to Wisler, that "he could attach a wire to it and talk for ten miles, as far as he could have a circuit around;" to H. F. Drawbaugh, that "he could talk across the continent;" to Free, that "the talking machine could be used to talk at a long distance—from Philadelphia to California;" to Landis, "that it could be used a thousand miles; it would take the place of the telegraph;" to Lenig, that "he could talk hundreds of miles through that;" to Updegraff, that, "instead of using the old mode of telegraphing, he could talk directly through the wire; he thought he could talk as far as you could use the ordinary telegraph wire;" to Draper, that "he thought it was, or would be, one of the greatest inventions of the age, and would take the place of telegraphing;" to A. Evans, that "he could take this machine and talk clear out to Europe, cross the ocean;" to Eicholz, that "if he could only get some one to help him once, he would run it to Harrisburg, and convince them, and then he would run it from Harrisburg to Philadelphia."

He stated to the witness Shank that "it works by electricity;" to Smith, "it was by electricity;" to Nichols, that "the sound was conducted by electricity;" to C. Eberly, that the instruments were "to convey sound by electricity;" to Coudry, that "they were operated by electricity;" to Shoop, that "it operated by a battery;" to Shireman, that "they operated by magnetism:" to Hawn, that "they would be operated on by a battery;" to N. W. Kahney, that "the machine was operated by electricity, by a battery;" to Zimmerman, that "it was electricity that would pass it over the wires; that it would carry the sound right along;" to Hale, that "it was driven by a magnet;" to H. K. Drawbaugh, that "the sound could be carried to a distance on a wire by the use of electricity;" to Lenig, that "electricity was used in connection with it;" to Prof. Heiges, that "in connection with a talking machine both magnetism and electricity were applied;" to Goodyear, that "his talking machine was also done by electricity over wires;" to Woods, that "it was to be an electric machine used in place of telegraphing;" to Young, that "it was an electric talking machine, which he had invented."

IS DRAWBAUGH'S STORY CREDIBLE?

Thus Drawbaugh is corroborated by a cloud of witnesses whose testimony tends to substantiate his narrative. Without

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stopping at this point to consider the credibility and probative force of their testimony, it suffices to state that, although some of the witnesses seem to have been reckless and unscrupulous in their statements, the great body of them are undoubtedly honest witnesses. It is impossible, however, to believe that Drawbaugh can be mistaken in the substance of his testimony, and the conclusion cannot be ignored that either his testimony is true in its essential parts, or his narrative has been manufactured to fit the exigencies of the case. In order to ascertain what effect is to be given to the corroborative proofs, it is important to determine whether Drawbaugh is an honest witness, or whether he has intentionally falsified collateral facts, and is therefore to be deemed discredited.

If the defence is to be believed, he had been experimenting with his talking machine from 1866, and had successfully transmitted speech as early as 1870, if not before that time. He testifies that he had used Exhibits "B" and "F" in transmitting speech for two or three years before he made Exhibit "C." According to the theory of the defendants' Exhibit "C" was made in 1869 or 1870. At that time he had reached a secondary stage in the development of his invention, and certainly as early as in 1872, when Exhibit "C" had received its latest modifications, the invention had passed out of the period of rudimental forms embodying principle merely, into a form embodying nice details of construction, and had reached a perfection not reached by Bell in his earlier patent. Drawbaugh was well aware of the merit and of the great pecuniary value of the invention; he had obtained patents for several inventions of minor value; yet from 1870 until July 1880, he did not apply for a patent for the telephone.

THE STORY OF DRAWBAUGH'S POVERTY DISPROVED.

It was of the first importance to explain the reason of his inaction, because it seems incredible that the inventor of the telephone should not only omit to patent it as soon as he could, but should also remain silent for years after others were winning the fame and profits of the invention. Only one explanation was possible, and that has been attempted. As stated in the answer, and in his testimony, it is that he was unable to do so by reason of his poverty. The answer alleges "that for more than ten years prior to 1880 he was miserably poor, and utterly unable to patent his invention or caveat it. He was asked the question: "Do you mean to have it understood from your last answer that there was any other reason for some period prior to 1870, except your poverty, whether greater or less, which prevented you from patenting your invention, or filing a caveat for it?" His answer was: "If I understood that right there was no other reason that I can think of now." He proceeds to state that Exhibits "F" and "B" exhibited the principle perfectly enough to patent.

In the elaborate efforts of the defendants to substantiate the theory of Drawbaugh's inability from poverty to patent his invention much testimony has been produced to show, and which does show, that he was always more or less in debt, often a borrower of small sums of money, was dilatory in paying his debts, and used to plead his inability when dunned, and was often sued and judgments and executions were obtained against him; but it is clear from a few plain facts that the theory of extreme poverty is unfounded, and that Drawbaugh is dishonest in putting it forward. In 1867 and 1869, besides what he received for his wages, he received $5,000 from the Pump Company for his faucet invention, besides $1,000 in the stock of the concern. On the first day of April, 1869, he received $1,000 from one Gardner, for the sale of a half interest in a faucet invention. He invested $2,000 of the $5,000 in real estate, lost $400 of it in an apple speculation, and used the $1,000 received from Gardner to buy a house and lot for his father Between 1867 and 1873 he paid $1,200 to the Drawbaugh Manufacturing Company for assessments on his stock, besides $870 in labor; and in July, 1873, received from that company $425 cash in settlement of its affairs.

From 1867 to April, 1872, he was the owner of real estate, for which he had paid $2,300 in the fall of 1867, and upon which he expended in improvements, in the spring of 1868, from $300 to $400, and which was encumbered only by a prior lien for $300. In the spring of 1872, he encumbered it for $1,000, not as a principal, but as a surety. He was in receipt of $110 annually, as rent, for a part of this property, occupying the rest himself, until he sold it in 1876, and bought another house in the town of Mechanicsville. He was always in receipt of fair wages for his labor.

From April 1, 1875, to April 1, 1876, he received nearly $450 for wages from the Axle Company, irrespective of his earnings from other sources, and declined steady work at times, because he could make more by job work. Thus it appears, that although at times it was not convenient for him to pay his debts, or he was careless or indifferent, he had not only the means of raising money during all this period, but that on many occasions he had means for investment and for speculation. The pretence that he could not raise the fees to caveat or patent his invention is transparently absurd.

He was accustomed to prepare specifications of patents, and was a maker of models, and advertised himself as an inventor, designer, and solicitor of patents. During the time he was experimenting on his talking machine, and before he applied for a patent, he found time and materials for experimenting with and making the Giffard injector for steam engines, the autograph telegraph, the magneto dial telegraph, the magneto key, the automatic fire alarm, and the electric clock. During this period he was a friend of Mr. Weaver, a patent solicitor, who frequently gave him advice and professional assistance, in return for mechanical services rendered by Drawbaugh, and who drew specifications for him for a measuring faucet and for the magnetic clock. If he was not competent himself to make an application for the patent, it cannot be doubted that, with the assistance of Weaver, he could have made a proper application at a trifling outlay, if any, beyond the fees of the office.

Drawbaugh devoted a good deal of time between 1867 and 1878 to the invention and construction of his electric clock; and the time and money expended by him in experimenting and constructing this clock in its various forms, especially those made in 1877-1878, was much more than would have enabled him to patent his talking machine. These clocks were built by him with his own tools and out of his own money, and to build them economically he made a gear-cutting machine, which must have cost him more than it would to patent his telephone. In April, 1878, he received $500 from the Electric Clock Company for the privilege of using his clock invention.

DEFENDANT'S TESTIMONY ON THIS POINT EXAMINED.

In order to fortify the theory of Drawbaugh's inability from poverty, to patent his invention, the defendants have attempted, by testimony from him and from others, to show that he was extremely solicitous to patent it, and tried to induce others to furnish the means. Mr. Springer testifies that "his (Drawbaugh's) whole mind appeared to be on his talking machine. He told me that many a night he didn't sleep, just studying how to improve it." After May, 1872, according to the testimony of Jacob Hawn, the talking machine superseded the clock in Drawbaugh's interest. According to Mr. Holsinger, from 1873 to 1876 "he appeared to be crazy on it. I often tried to get information from him on other subjects, and about half a minute's talk would turn him right on the talking machine."

Henry F. Drawbaugh, his brother, testifies: "Every time I was down there, from the summer of 1872 to 1879 or 1880, he was working at it, and talking, and wanted me to go in with him and furnish means." Mr. Bates says he "was in Drawbaugh's shop eight or ten times between the summer of 1874 and the fall of 1877, and "his general conversation was about the talking machine; said he would like to get it patented, but had not the means, and could make a fortune out of it." Drawbaugh testifies as follows: "Question. A good many witnesses have testified that you were at various times talking of patenting your electric-speaking telephone invention; what is your recollection about that? Did you intend to patent it or not? Answer. Yes, sir; I intended to patent it. I had spoken to a number of persons to assist me. I would state to them that I would give them an interest in the invention for them to furnish the money to have it patented. Question. Why did you not patent it with your own money? Answer. I didn't have any money. Question. At how early a time did you have the intention of patenting it? Answer. I could hardly say how early. I spoke to persons even at an early time. I spoke to Christian Eberly. It may have been prior to 1870, I spoke to Frank Lee. I spoke to them about taking an interest. They were among the earliest. I can't remember all the persons, as I had spoken to a great many. Lee is not a witness, having died in 1872."

Christian Eberly locates the time as between 1867 and 1870. He had been a partner with Drawbaugh in a number of inventions, and was a capitalist. He was asked, "When Mr. Drawbaugh showed you his talking machine, state whether he proposed to you to go into partnership with him, and furnish the money for that also, as you had before that time on the other inventions?" He answered: "Not altogether; he intimated that he would take me in. I don't recollect as I said anything, or what I said." The witness was often in Drawbaugh's shop subsequently, in 1871, 1872, and 1873, but mentions no other proposition."

The only other persons Drawbaugh specifies as having been applied to by him are Capt. Moore, Henry Bayler, and Simon Oyster. Oyster was not called as a witness. Capt. Moore was examined as a witness for the defendants, and his testimony is significant. He was the principal of the Soldier's Orphan School, an institution in the vicinity of Eberly's Mills, and was the secretary and treasurer of the Axle Company, a concern that in part occupied Drawbaugh's shop in 1875 and 1876. He testifies that about May, 1875, Drawbaugh showed him a talking machine; said he was unable to patent it himself, and desired witness to "go in with him and get a patent." He states that he told Drawbaugh he didn't want to go into any new inventions, but that it would be a fortune to any person bringing it out, if it could be put to practical use. He identifies "Exhibit B" as the only machine shown him at that time by Drawbaugh.

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Although he and Drawbaugh maintained intimate business relations for a year after that time, the subject seems never to have been referred to again. Mr. Moore was an intelligent capitalist. It is strange that Drawbaugh should have shown him "Exhibit B," one-half of the crude instrument of 1867-1869, if the perfect instruments "E" and "D" were in existence; and more strange that the subject was never mentioned again between them, or that no attempt was made to speak through any machine, if they had any faith in the value of the invention.

Mr. Bayler, the other witness, carried on lumbering and a saw mill from 1873 to 1877, in the vicinity of Milltown, and employed Drawbaugh frequently to repair machinery. He testifies that in June, 1873, Drawbaugh showed him the talking machine, and he said to Drawbaugh, "Why, Dan, that is virtually a talking telegraph," and advised him to take out a patent for it; to which Drawbaugh replied, "If I had the means, I would. If you'll advance me the means to procure a patent, I'll give you a half interest." The witness continues: "Generally on him meeting me he would urge it, urge me to take an interest by furnishing him the means to take out a patent." He also identifies Exhibits "F" and "B" as the instruments shown him by Drawbaugh. But his books show that during all the time from April, 1873, to May, 1876, he owed Drawbaugh more than the fees necessary for procuring a patent.

The defendants produce other witnesses to prove that from 1870 to 1879 Drawbaugh was showing his telephone, adverting to his property, and trying to induce somebody to assist him. Mr. Herr may be cited as an illustration. He testified that in 1870 or 1871 Drawbaugh wanted money to get a caveat to secure his invention, and told the witness if he would help him, or procure any person to assist him, he would give him a half interest. Without adverting further to the testimony on this subject, it is sufficient to say, in view of the fact that there never was a time from 1867 to 1880 when Drawbaugh did not have the money to caveat and patent his invention or the means of borrowing it, that the only legitimate effect of such testimony is to discredit the whole defence by exciting the suspicion that it is bolstered up by exaggerated and unreliable testimony.

It will hereafter be shown that among the men with whom Drawbaugh maintained business and friendly relations during this period, there were many of intelligence and means. Some of them may have distrusted his judgment, and regarded him as a visionary. Some of them may have been indifferent or timid. But it is incredible that when only a trifling sum was required for a half interest in the invention, none of them could be sufficiently impressed with its merit or financial value, to investigate it seriously as a speculation or an investment. He induced persons to invest in faucet inventions, and in his magnetic clock; and it cannot be true that he could find no one to entertain the talking machine, which, according to the common rumor of the neighborhood, was to supersede the telegraph, and, in the words of one of the witnesses, "make Drawbaugh the richest man in the Cumberland Valley."

It was very natural that a hard-headed old farmer like William Darr, on being told by Drawbaugh that he had a machine by which he could talk across the Atlantic Ocean, should advise him to "try it first in talking across the Yellow Breeches Creek," but it is beyond comprehension or belief that none of the capitalists or speculators about him could be induced to seriously consider it, if it was an operative device.

DRAWBAUGH'S VERACITY IMPEACHED.

Where a witness falsifies a fact in respect to which he cannot be presumed liable to mistake, Courts are bound "upon principles of law, morality, and justice to apply the maxim *falsus in uno falsus in omnibus*." (The Trindad, 7 Wheat. 283.) Drawbaugh could not be mistaken in asserting that it was his poverty which prevented him from caveating or patenting his invention. He was not led to the assertion inadvertently. Those with whom he is associated in the defence understood fully, and so did he, that the fact that a professional inventor and patentee did not go to the Patent Office to secure an invention like the telephone for ten years after it had been completed and demonstrated, was almost conclusive against the theory that he had made the invention; and that unless this presumption could be parried, no Court would credit his story. The theory of constraining poverty was therefore formulated in the answer, elaborately fortified by witnesses, and testified to by Drawbaugh. It is overthrown by a few plain, indisputable facts, and Drawbaugh's veracity falls with it.

TESTIMONY OF CORROBORATIVE WITNESSES CONSIDERED.

The defence must rest upon the testimony of the witnesses who corroborate Drawbaugh. The case made by these witnesses is sufficiently formidable to overcome the legal presumption of the validity of the complainants' patents. It is met by the complainant with rebutting evidence direct and circumstantial, showing the intrinsic improbability of the theory that Drawbaugh was the inventor of the telephone, and showing his conduct or declarations inconsistent with any hypothesis that he was more than an unsuccessful experimenter with the invention. Many witnesses have also been produced by the complainant to attack the credibility and reliability of the testimony of the defendants' witnesses. Of necessity the testimony of most of the defendants' witnesses can only be attacked by showing that the witnesses are mistaken as to the time when they saw Drawbaugh's talking machine, or as to what they really saw on the occasions they refer to.

The way in which the testimony of Uriah P. Nichols is met will illustrate the general tenor of such testimony. Mr. Nichols was one of the most intelligent and trustworthy of the defendants' witnesses, a farmer and machinist, who testified that on the 18th day of January, 1875, he visited Drawbaugh's shop on business, saw two instruments, which he identified as Exhibits "B" and "A," and he described their mode of operation as stated to him by Drawbaugh at the time. He says he listened at one instrument while a boy spoke into another 200 feet away, connected by wires, and heard the boy say: "Is it you, father, speaking?" The complainant produces nine witnesses to show that the occasion could not have been prior to February, 1878. The witness fixes the date by a purchase of lime made by him on the visit, and states that he went to Drawbaugh's to see an electric clock of which he had recently read a description in a newspaper, and soon after the visit told Mr. Maish and others about the telephone he had seen at Drawbaugh's.

The complainant proves that the newspaper article was not published until February, 1878; that when the witness told Mr. Maish of the telephone at Drawbaugh's, the latter, who was then a member of Congress, remembered the occasion, knew all about Bell's telephone at the time, and had used it in Washington. Mr. Maish states that, as Drawbaugh was one of his constituents, he would have been deeply impressed by the conversation if he had understood Drawbaugh claimed to be the inventor. Without attempting to particularize the rest of the testimony for the complainant upon this issue, it suffices to say that several other witnesses were introduced to show that the lime was not purchased by Nichols before 1876. Much testimony is given by complainant upon collateral issues of a similar character.

One of these issues relates to the time when Thomas Draper ordered a hydraulic ram of Drawbaugh. Mr. Draper was an important witness for the defendants. He testified that he went with Mr. Kissinger, a tenant of his, to Drawbaugh's shop in May or the early summer of 1874, for the purpose of ordering of Drawbaugh a hydraulic ram to be used upon the farm Kissinger had leased of him in April, and that he was never at Drawbaugh's on any other occasion. He identified Exhibit "C" positively, and Exhibit "I" less positively, as the instruments used and through which he listened while Drawbaugh talked.

The complainant proved that the hydraulic ram was not put to use until the fall of 1878, and undertook to locate the date of Draper's visit approximately by that fact. Seventy-five witnesses were introduced by the respective parties upon this collateral issue. These illustrations show how hopeless a task it would be to review the testimony satisfactorily or analyze it minutely. Five hundred witnesses have been examined by the parties upon the main question and the collateral issues, and their testimony is in a printed record of over six thousand pages. If it were practicable to do so, it would not be profitable, because a microscopic view of the controversy would be inadequate and misleading.

LEADING FACTS IN THE CASE MUST GOVERN.

In cases where such a chaos of oral testimony exists, it is usually found that the judgment is convinced by a few leading facts and *indicia*, outlined so clearly that they cannot be obscured by prevarication or the aberrations of memory. Such facts and *indicia* are found here, and they are so persuasive and cogent that the testimony of a myriad of witnesses cannot prevail against them.

The first group of facts of this nature are those which bear upon the capacity and character of Drawbaugh as an inventor, and tend to show that it is not only highly improbable, but almost impossible, that he could have been the author of the telephone.

AUTOBIOGRAPHY OF DRAWBAUGH.

In the summer of 1878 he composed a biography of himself for publication in the history of Cumberland County, which presents a graphic picture of the inventor and of the man. He commences by describing himself as "born in the quiet, secluded village of Milltown, three miles from Harrisburg," and as "one of the greatest inventive geniuses of this age, who has spent the greater part of an active life conceiving and producing, as the result of the conceptions of an unusually fertile brain, a score of useful, ingenious machines and devices. It appears," he says, "by examining a list of his inventions, that the manufacturing interests of the place in his boyhood days gave direction to his thoughts and incentive to his actions." He proceeds to enumerate a list of his inventions as follows: "His first invention was

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an automatic sawing machine; then a number of machines used in wagon making; then a machine for boring spoke tenets; then a machine for sawing tenets; a barrel stave jointing machine, patented in 1851 This machine was pretty generally introduced, and its merits appreciated; an automatic grinding machine was next invented to meet a demand created by the introduction of the jointer; then followed several machines for making stave headings and shingles, all of which were patented in 1855; after which, machines for rounding, heading, crozing, dressing and finishing outside of barrels were invented; these were again followed by device for running mill-stones; one for dressing mill-stones; a device for elevating grain in mills. He then invented and had patented four improvements in nail plate feeding; next a tack machine, and a new design in tacks. Photography next engaged his attention. He fitted himself for action in this field by manufacturing his own camera, ground and fitted acromatic lenses for camera, prepared the necessary chemicals, and improved the process for enlarging pictures. Next electricity and electrical machinery attracted his attention, and an electric machine was produced throwing out of consideration the galvanic battery and electric pile; then a machine for alphabetical telegraphing; then the justly celebrated electric clock, and the machinery necessary for its construction; and several kinds of telephones, one of which is operated by battery, and another by induction." He concludes as follows: "It will be seen from the foregoing that Mr. Drawbaugh has penetrated vast fields in search of information, and with what success we leave it to the readers to determine. We are proud to own Mr. D. as a citizen of our township, and deem him worthy of a position at the head of the list of our prominent men, and are happy to accord him that position." This portrait, drawn by himself, depicts without the aid of extrinsic evidence, the ignorance and vanity of the man, and incongruous and fantastic assortment of his inventive projects. It suggests, also, the character of a charlatan.

DRAWBAUGH NOT AN INVENTOR IN THE LARGE SENSE.

That he was a skilful and ingenious mechanic is undoubtedly true. Invention was his hobby and his vocation, but that he was an inventor in the large sense is disproved by the nature and results of his work. Every patent that he obtained was for some improvement on existing devices which involved mechanical skill rather than any high degree of inventive faculty. This is shown to some extent on the face of his patents, the list of which is as follows:

Nov. 11, 1851, "for improvement in stave jointing machines;" May 22, 1855, "for stave machines;" April 28, 1864, "for improvement in mill stones;" May 12, 1863, "for improved machine for leveling the faces of mill stones;" Dec. 12, 1865, "for improvement in nail plate feeders;" Nov. 20, 1866, "for improvement in faucets;" Nov. 19, 1867, "for improvement in nail feeding device."

His own testimony, given in an interference proceeding in the Patent Office in 1879, shows that none of his inventions were sufficiently meritorious to prosper vigorously. That proceeding involved a question of priority of invention between himself and one Hauck, respecting an improvement in a faucet. He had filed his application for a patent in January, 1879, and undertook to carry back the date of his invention to 1869. The scope and range of his inventive faculty became a subject of inquiry. He there testified that he had made "he might say fifty inventions, and had patented over a dozen." He was cross-examined respecting certain inventions to show that they did not work satisfactorily. He was then asked: "Since 1866 what machines have you conceived and perfected that have worked satisfactorily?" He answered: "To the best of my knowledge, I think they all have. The nail machine gave satisfaction. I had it running in the works, but the nailers drove it out. The tram and red staff was a good machine, and adopted by a number of millers. The magnetic clock I consider a good thing, but I am not through with experiments on it yet. I believe this last faucet to be a good thing."

If his nail machine had induced the workmen to drive it out of the shop, it ought to have commended itself to the capitalist. His magnetic clock had not been patented at this time, though it had been for a time the wonder and admiration of the community in which he lived; but when it was patented, in 1879, it was as a "new article of manufacture," consisting of a galvanic battery for electrical clocks, which had two old elements united instead of being disconnected as in former devices. The history of this clock shows clearly that it was of no practical merit; and the clock had been substantially described in Tomlinson's Encyclopedia, and he had the book before he made his alleged invention. His other electrical devices he never patented, and in his testimony in the interference proceedings he did not refer to them as among his perfected and successful inventions. One of these was his magneto-electric machine for short line telegraphing and fire alarms, sometimes mentioned as his "magneto key." It was not a new device, and the proofs show that it was a failure.

CHARACTER OF THE TELEPHONE INVENTION.

When the speaking telephone was first introduced to the attention of the scientific public, it was pronounced by one of the most eminent electricians of the day "a result of transcendant scientific interest,' and "the greatest by far of all the marvels of the electric telegraph." The inventions attributed to Drawbaugh include not only the conception of the principle of the unbroken, undulatory electric current, and of the delicate and complex instrumentalities essential to its efficient application in transmitting and reproducing articulate speech, but also of many other devices involving a nice adjustment of forces, and requiring sensitive mechanism. These were inventions of a peculiarly scientific order, which would seem to demand a special conversance with the principles of acoustics and electricity. Besides making the cardinal discovery of the theory of the unbroken, undulatory current, Drawbaugh is assumed to have perfected a brilliant and extraordinary series of original discoveries, for which, to use the words of Mr. Benjamin, "there is no parallel instance in the whole history of invention." Mr. Benjamin, referri g to the microphone, which was introduced to the public in 1878 by Mr. Blake, but which is one of the instruments asserted to have been invented by Drawbaugh at an earlier date, says: "It was looked upon as a great and original discovery."

THE LABORS OF BELL AND DRAWBAUGH CONTRASTED.

It was said by Chief Justice Taney (O'Reilly v. Morse, 15 How., 111), speaking of the invention of the telegraph: "No invention can possibly be made consisting of a combination of different elements of power without a thorough knowledge of the property of each, and the mode in which they operate on each other. For no man ever made such an invention without having first obtained this information, unless it was discovered by some fortunate accident." None of Drawbaugh's alleged discoveries were made by accident His statement is that starting with the belief that speech could be transmitted by electricity, he made first one contrivance and then another, gradually obviating difficulties and making advances experimentally, until he finally perfected the several inventions.

In view of Bell's special equipment for investigation and experiment in electrical and acoustic science, it would not seem strange that his persistent efforts to effect the electrical transmission of speech were eventually successful, were it not that others as intelligent, as well equipped, as ingenious, and as persevering as he, had devoted years to the same object in vain. He had the assistance of Mr. Watson, an expert in electricity and a skilled workman in electrical mechanism, in constructing the apparatus employed in his experiments, and who also aided him in his experiments. He had demonstrated his inventive proficiency by inventions in telegraphy, for which patents were granted to him. And yet, had it not been for an accidental discovery made by him in June, 1875, and which would probably have escaped one whose trained faculties were not centered on a careful study of the phenomena, he might have failed.

Drawbaugh, on the other hand, was not only untutored, but he was isolated by his associations and occupations from contact with men of advanced science; he had narrow opportunities for instruction, and few incentives for profound research. Among the multitude of his inventive conceptions was one that a talking machine was a possibility. According to the testimony of Lory, a witness for defendants, before Drawbaugh began his practical experiments, he exhibited a sketch of a machine that he was about to make that would talk a distance of twenty miles, and work something like a telegraph. If this is true, he commenced on his telephone as the architect plans a building, or the engineer makes a draught of his structure. His own testimony shows that he did not attempt to qualify himself for electrical inventions by any systematic study after he began experimenting with his talking machine. Although he had undoubtedly acquired considerable desultory information about electricity, and especially about the mode of operation and detail of construction of electrical mechanism, it is obvious that when he commenced with his talking machine he was a tyro in electrical science, essaying the most difficult work of the electrician. It is almost incredible that the subtle intellectual discoveries, which were a closed book to the ablest electrician, could have been reached by a smatterer in science, or by any series of empirical experiments.

MENTAL DEVELOPMENT OF INVENTION UNACCOUNTED FOR.

As has been remarked, he seems to have discovered nothing accidentally; yet, from the beginning to the end of his narrative, there is nothing to indicate the conceptive origin or the mental growth of the alleged invention. He presents a number of devices in the chronological order of their production, and testifies that he made one and then another and another, as experiments led him to modifications and improvements. He cannot describe what receiver or other apparatus he used with his first transmitter, and testifies: "I had a number of crude apparatuses,

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but can't remember exactly the shape of any of them. I had membranes stretched over hoops—over a hoop—I remember that; and I had electro magnets, and the arrangement was varied; I don't remember exactly the arrangement."

He testifies that when he used the cup machine he used it in a continuous electric circuit, and thinks he used it as a receiver with Exhibit "B" as a transmitter. He states that he succeeded in transmitting speech with these two instruments, and, of course, he could only have done this by employing the unbroken undulatory current of electricity. He cannot state how he conceived the initial idea of the undulatory current and the continuous circuit, or subsequently the theory of any of the remarkable devices which he produces. His answers to questions intended to elicit such information may be illustrated by giving one of them: "I don't remember how I came to it; I had been experimenting in that direction; I don't remember of getting at it by accident either; I don't remember of any one telling me of it; I don't suppose any one told me.' He produces sketches, or models, or originals of instruments, which he says he made from time to time; he states that they were used to talk through on various occasions; and from these outlines of accomplished facts, leaves the history of his inventions to be filled out by inference and conjecture. An inventor can hardly forget the process of thought by which a great intellectual conception germinates and matures into the consummate achievement; but Drawbaugh's memory is a blank. If the untutored mechanic educated himself into an accomplished electrician by his own experiments and observations, the incidents and phenomena which revealed new discoveries and illumined the way for new advances would be indelibly impressed upon his mind. It seems a little short of the miraculous that a man of his capacity and equipment should have produced these inventions at all; more marvelous still that he should have produced them without any intellectual perception of his discoveries.

DRAWBAUGH'S STORY DISPROVED BY HIS OWN CONDUCT.

Another group of important facts, which are satisfactorily shown by the proofs, are those which indicate Drawbaugh's own knowledge that he was not an original inventor of the telephone. Reference has been made to some of the evidence bearing upon his neglect to patent or caveat his invention, in discussing the question of his credibility as a witness.

If no honest and reasonable explanation can be given for his conduct, the inference is very strong that he knew he did not have a practical telephone to patent. He may have had a talking machine, which was well calculated to excite the curiosity of the community in which he lived; he may have indulged in expectations that in time he could succeed in making a practical speaking telephone and reap fame and profit from it; but his conduct is almost decisive against the supposition that he had even deluded himself with the belief that he had produced anything sufficiently practical and valuable to patent. He never attempted to exhibit it outside of his own shop to prove that it would transmit speech at a distance of even a quarter of a mile. The proofs show that during all the years, from 1867 to 1878, he did not attempt to avail himself of opportunities for demonstrating his invention and bringing it to the notice of friends who were peculiarly qualified to appreciate, and were favorably circumstanced to assist him. One of these persons was a Mr. Kiefer, who resided at Harrisburg, from 1863 to 1881, and during that period had charge of the telegraphs of the Pennsylvania Railroad Company, and was a member of a firm whose business was the manufacturing of fine electrical machinery.

In 1873 he put up a fire-alarm system for that city. Drawbaugh made his acquaintance in 1874 or 1875, and brought his magnetic fire alarm to Mr. Kiefer for examination. At another time, he brought the works of his electric clock. He visited Mr. Kiefer on various occasions, obtained small supplies from him, and habitually conversed with him upon the subject of his electrical contrivances. The period of these visits begins just about the time when, according to the theory of the defendants, Drawbaugh had constructed Exhibits "E" and "D," and the invention was complete. He never mentioned to Mr. Kiefer the fact that he had experimented with a telephone. Mr. Wilson was superintendent of telegraphs for the Northern Central Railway Company, at Harrisburg, from 1864 to 1875. He was also mayor of Harrisburg. The company had an electrical workshop and supply establishment there for Mr. Wilson's department between 1871 and 1875. During this time Drawbaugh often came to the supply shop, and talked with Mr. Wilson about electrical experiments, and obtained parts of batteries, coils, magnets and other electrical material which the company had cast aside. He brought Mr. Wilson his electric clock and his magneto-electric key, and tried his machine for short line telegraphing at Mr. Wilson's office. He talked with him frequently about his inventions; but he never mentioned the telephone. His relations with David A. Houck were such that the latter procured him an opportunity to test his magneto key at the telegraph office of the railroad company at Mechanicsburg. Mr. Stees was the superintendent of a car company at Harrisburg, having shops in different parts of the city connected by telegraph lines. He was the first person to employ Bell's telephone on these lines, when they were introduced into Harrisburg late in 1877 or early in 1878. He was a friend of Drawbaugh, and Drawbaugh would naturally have applied to him if he wanted to test his telephone publicly and practically.

Isaac Lloyd was a school teacher and an alderman at Harrisburg; had known Drawbaugh long; was accustomed to visit his shop from time to time; saw many of Drawbaugh's inventions; was present on one occasion when Drawbaugh experimented with his magneto device for telegraphing at Mr. Wilson's telegraph office. Drawbaugh visited him frequently, and they were accustomed to converse about Drawbaugh's inventions. Drawbaugh showed him his dial telegraph, his electric fire alarm apparatus, and numerous other inventions. Witness assisted him about the electric clock. He was an owner of patents and a friend to whom Drawbaugh applied for loans, and was interested in mechanical subjects generally. The only mention ever made to him by Drawbaugh about a telephone was in 1878, when Drawbaugh told him he was experimenting with a telephone. From 1867, to July 1873, Drawbaugh was intimately connected with the persons composing the Drawbaugh Manufacturing Company, which was engaged in manufacturing devices under Drawbaugh's patents. He was a stockholder and the master mechanic of this company. Among the officers and stockholders were many men of capital and enterprise. There came a time when the managers of this company wanted Drawbaugh to suggest new devices for the company to manufacture. He never suggested the telephone nor attempted to induce the managers of that company to investigate or exhibit his talking machine. A number of the managers and employees of this concern testify that they never heard of the existence of the talking machine during the life of the company. Without attempting to refer to other testimony to the same general effect, what has already been referred to, shows that if Drawbaugh had seriously desired to bring his talking machine into public notice and secure the fruits of his invention, he had ample opportunity to do so. Who can doubt that if he had a practical telephone to exhibit, he would have selected just such men as Kiefer, Wilson, and the others to demonstrate it to them, and enlist them to demonstrate its utility and value to the public?

Such an invention was of a kind well calculated to excite public interest and to impress practical men with a quick appreciation of its commercial importance and its pecuniary value. It was so sufficiently perfected, according to the theory of the defence, that a patent could have been obtained prior to 1870, to secure the application of the principle and to compel every subsequent inventor to pay tribute to the discoverer of a new art. For years it was mechanically perfect, and its efficiency and importance as a great factor in human intercourse could have been demonstrated to the public without appreciable inconvenience or expense. Drawbaugh fully appreciated its importance and value. He had the means to patent it himself, and friends to assist him in introducing it into public use. He had the talent to induce others to invest in his inventions. No explanation is possible why, under such circumstances, his efforts should have left no mark upon the annals of inventive progress, and given no evidence of life beyond the idle curiosity his talking machine excited in the circle of his admirers during all these years. His conduct is more persuasive to show that he did not have a practical, operative telephone, than the testimony of a multitude of witnesses who may have seen and heard talking machines at his shop during this period. But the complainant has given evidence of his declarations, made by him, before he had any interest to pervert the truth, which afford a reasonable explanation of his conduct, and go far to explain how the testimony of the corroborative witnesses may be reconciled with the truth.

In 1874-6 Drawbaugh issued a business card, advertising himself as "Inventor, designer, and solicitor of patents." On the back of this card is printed a list of his inventions, as follows: "Stave heading and shingle cutter; barrel machinery; stave "jointing machine; tram and red staff for levelling face of mill "stones; rine and driver for running mill stone; nail machinery "for feeding nail plates; pumps, rotary and others; hydraulic "ram; the Drawbaugh rotary measuring faucet; carpet rag "looper; electric clock and magneto-electric machine for short- "line telegraphing and fire alarm, and propelling electric clocks." He takes pains to say of this magneto machine on his card that it "can be applied to any form of electric movement, and dispenses with a galvanic battery." He had obtained patents for some of these inventions, but had not for others. He was then experimenting with his electric clock, and with his magneto-machine for short-line telegraphing, fire alarms, etc., and included them in the list of his inventions. The omission to mention the most important one of all his inventions, one respecting whiich, according to his present testimony, there had not been a week from the time he made his first cup machine that he had not been engaged with it, one which was complete before his electric clock was complete, is a significant statement by implication that he had no such invention to advertise.

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It is to be remembered that when he chronicled his achievements in the autobiographical sketch of 1878, the Bell telephone had been introduced into commercial use at Harrisburg, three miles from Drawbaugh's shop and the local newspapers had been full of the subject. The cursory allusion in that autobiography to "several kinds of telephones," is in striking contrast with the elaborate description of the electric clock, and wholly inconsistent with the theory that he deemed himself to be the originator of the telephone which, at that particular time, was a topic of universal interest.

In his testimony given in 1879, in the interference proceeding with Hauck, although he did not include the talking machine in the category of his successful inventions in the course of his testimony, he produced a sketch of his faucet, and stated that he made it "about 1874 to 1876, when I was experimenting on telephones or phonographs." He represented himself not as an inventor of that which he is now claimed to have perfected, but as an experimenter with a "telephone or phonograph." It is instructive to read this statement in juxtaposition with a statement made by him to Mr. Matthews in the preceding year. Mr. Matthews was the managing editor of the *Baltimore American*, and in April, 1878, made a visit to Drawbaugh at his shop to see Drawbaugh's magnetic clock, in consequence of information received from a correspondent. He was a careful observer, who went there obviously for the purpose of writing an article for his paper. That his memory is unusually retentive and accurate, and that he is a careful and conscientious man, is apparent from a letter written by him in December, 1883, after the proofs in the case had been closed, and in which he manifests a desire to correct certain errors of detail in his deposition. Upon that visit his attention was chiefly directed to the clock, but he examined Drawbaugh's other inventions, and conversed with him about them; and, among other things, conversed about the telephone. Drawbaugh's statement to him on that occasion was, that he had invented apparatus to send messages by means of an alphabet founded upon difference of sounds. He did not profess to be the inventor of the speaking telephone, or assert that he had ever transmitted speech successfully with his apparatus. He said that the idea of transmitting sounds in this manner was not new, and that he had read of it some years before in a publication translated from the French; and he denied Bell's right to claim the invention of the telephone, because of that publication.

In the article founded on that interview which Mr. Matthews subsequently wrote for publication in the *Baltimore American*, he adverts to the several useful agricultural, and mechanical devices patented by Drawbaugh, and adds: "It may be mentioned that Mr. Drawbaugh constructed a rude telephone long before Mr. Edison loomed up as the 'boss' inventor. He never expected to send articulate sounds over a magnetized wire, but he believed that an alphabet could be arranged after the manner of the musical scale, and that messages could be transmitted and understood by the variations of tone and pitch. This unlettered mechanic came very near anticipating Edison and Bell in the invention of the telephone, and nothing but his poverty prevented him from conducting his experiments to a successful issue."

His advertising card, his testimony before the Patent Office, his autobiography, and his statement to Matthews, authenticated in writing, were all made when he had no pecuniary interest to color the facts, and upon occasions when he was anxious to present himself in the most favorable light as an inventor; and they were all made after his talking machine, according to the theory of the defendants, was a perfect invention and known to be such by many of his friends and neighbors.

These are declarations evidenced in writing, and one of them made under oath, which point in but one direction. They are consistent with his conduct. They show that he understood himself to be an experimenter with telephones or phonographs, but not the inventor of the speaking telephone.

EVIDENCE OF COMPLAINANT'S WITNESSES CONSIDERED.

The complainant has supplemented this evidence by the testimony of other substantial witnesses who had favorable opportunities to know what Drawbaugh had invented, and who describe what they saw and did not see at his shop, and narrate what he said about his talking machines on various occasions. This testimony indicates that, at as late a period as in 1878-9, Drawbaugh was an experimenter, but not the author of the parent invention, nor one who had perfected any valuable improvement upon it; and is in substantial accord with his statement to Mr. Matthews and his testimony in the interference proceedings. What gives point and force to this testimony and parries the ordinary objections to the reliability of verbal declarations, is that these witnesses are persons who would have been forcibly impressed, because of their interest in the particular subject, by any assertion by Drawbaugh that he was an inventor of the telephone. During the time in question Drawbaugh had friendly relations with the newspapers of the vicinity; his friends were frequently communicating laudatory notices of his mechanical and inventive efforts to the press; and he himself visited one of the newspaper offices in the spring of 1878, to show a telephone he had made. These newspapers had published articles about the Bell telephone; but up to the spring of 1878. while many notices had been published in them about his electric clock and other inventions, describing him as a man of extraordinary genius, there had been no mention of the telephone; and when, in the spring of 1878, the subject was mentioned, he was referred to as one who was "inventing a telephone on a different plan from that now occupying the attention of the scientists," and as about completing "the new telephone he is now constructing."

In this connection it is to be noted that soon after telephones were introduced in Harrisburg, late in 1877, or early in 1878, Drawbaugh visited the offices where they were used, examined the inside of the instruments, and borrowed one to take home, which he kept for several days; and the instrument which he borrowed bears a close resemblance in appearance to Exhibit "A," which it is asserted he had made in 1873 or 1874.

No extended reference will be made to the testimony of other witnesses, such as Mr. Weaver and Mr. Grissinger, showing declarations of Drawbaugh made after the Bell Telephone was in commercial use to the effect that, although he had experimented on the telephone years before Bell, he had obtained no satisfactory results.

EFFECT OF TESTIMONY FOR DEFENCE DISCUSSED.

It remains to consider what effect is to be given to the testimony of the multitude of witnesses who have been produced to substantiate the defense. Disregarding the testimony which is merely hearsay, and therefore incompetent as evidence of the main fact, the testimony of many other witnesses is overthrown by the palpable improbability of their statements, or by the contradictions between their statements and those of other witnesses for the defendants upon substantiative points, or by successful attacks upon their accuracy in the rebutting testimony of the complainant.

There still remains a formidable number of witnesses who testify to seeing or using Drawbaugh's talking machine, and some of whom identify particular exhibits as the instruments which they saw or tried.

No doubt is entertained that Drawbaugh was experimenting at an early period with telephones or phonographs. He knew about the phonographs or phonautograph of Scott as early as in 1863. The membrane diaphragm excited by sonorous waves, and the mechanism of the phonograph were not novelties, and, among the diversity of inventive possibilities had probably attracted his interest. Prior to the issue of Bell's patent, Dr. Van DeWeyde had made public experiments with the Reis telephone at the City of New York, and others had made like experiments elsewhere. In May, 1869, a full description of the instrument and of the experiments was published in the newspaper, "*The Manufacturer and Builder*," treating it as a highly interesting curiosity, which contained the germ of great practical purposes. Whether other newspapers noticed the experiments or not is not shown, nor is it shown that Drawbaugh saw the article in "*The Manufacturer and Builder*." It would be difficult to prove the circumstances if he did see it. Some such publication probably stimulated him to experiment. If he made a sketch of the mechanism at the start the material for it was at hand. As is stated by Mr. Benjamin, it has been asserted of the Reis instrument, that certain sounds of the human voice can be transmitted by it, but in truth these are merely fragmentary reproductions of vocal sounds, and the transmission of articulate speech could not be effected because it was constructed on the make and break principle, instead of on that of the undulatory unbroken current.

It is not strange to any reader of the autobiography that Drawbaugh should have taken up the telephone. That he and those about him should have treated it as a talking machine is entirely natural. That his talking machine as late as in 1876 bore a striking resemblance to the Reis telephone is shown by Mr. Shapley's testimony, a witness who noticed the resemblance and loaned Drawbaugh a copy of the *Scientific American* describing it.

There is enough here to explain Drawbaugh's declarations to his neighbors about the talking machine he was inventing, and to excite the curiosity of the community. A careful reading of the proofs renders it easy of belief that the witnesses who testify about casual visits to his shop, which occurred many years before their testimony was delivered, and to cursory tests of his instruments on those occasions, have confused the fragmentary and incoherent articulation of such an apparatus with the hearing of distinct words and sentences. When witnesses undertake (as many of them do), to give the exact words or sentence heard in the instrument five or ten years before, when their attention was not called to the subject afterwards, no hesitation is felt in rejecting such statements as utterly incredible. It may be charitably inferred that such a witness has confused his recollection with more recent impressions. As will hereafter be shown, the proofs demonstrate that most of the witnesses who testify to having heard distinctly and coherently through the talking machine, all those who indicate the Exhibits "B." "F," and "C" as the instruments, are mistaken if they are truthful. If Draw-

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baugh was a charlatan, he may have assisted in deluding them; and the proofs show, that between 1872 and 1874, a string telephone was in his brother's shop, in the village. The fact that he never attempted to exhibit his machine outside of his shop where it could be used between points some considerable distance apart, and where its real capacity could be readily observed, is significant in this connection.

The more important testimony is that by which it is sought to identify the several exhibits, and show their existence at times consistent with the theory of the natural evolution of the invention. The identification of particular exhibits as seen by the witnesses among the various objects of curiosity at Drawbaugh's shop several years before they testify, is necessarily unreliable when it is attempted by observers who had no knowledge of the mode of operation or of the internal organization of the instruments. Such witnesses could not appreciate what they saw even if they examined the instruments. Most of the witnesses belong to this class. Indeed, the greater proportion of them do not profess to identify the exhibits positively. Some are more certain than others that particular exhibits are the instruments they saw. Exhibits "F," "B," and "C," are fragmentary remains of instruments, and their value depends upon Drawbaugh's description of the operative parts that no longer exist. Scores of witnesses testify to seeing the tumbler device resembling Exhibit "F," and the tin can device resembling Exhibit "B," but the identification of the other exhibits prior to the date of Bell's patent is comparatively feeble.

The appearance of Exhibits "F," "B," and "C" is sufficiently peculiar and distinctive to impress the memory of those who saw them. On the other hand, the other exhibits are not of this character, and all that ordinarily the witnesses can safely say of them is, that five years or more before testifying they think they saw or used a small walnut box externally resembling "I," or "A," or "E," or "D."

It may be said generally of all the testimony of the witnesses who attempt to identify exhibits, that it is mainly valuable when it proceeds from those who used the instruments which they think they remember and obtained results. They must remember the results obtained much better than the minor differences of appearance presented by the instruments Granting that Exhibits "F," "B" and "C" would be likely to be remembered, what shall be said of the value of the testimony of scores of witnesses who state that they tested these instruments, or saw others test them, and they articulated perfectly, when it appears by the most authentic test that these instruments were incapable of such articulation?

RESULTS OF TESTS OF DRAWBAUGH'S APPARATUS.

In March, 1882, after most of the proofs in the case had been taken, a test was made of the capacity of the exhibits to transmit speech in the presence of the counsel and the experts for the respective parties. It is not accurate to say a test was made of the exhibits; but reproductions of "F," "B," and "C," were made by Drawbaugh and as rehabilitated by him, were used for the test. Whether these were honest reproductions, no one can tell; but such as they were, they were experimented with by Drawbaugh before they were subjected to the test. Whatever else that test demonstrated, it proved that articulate speech could not have been practically communicated through Exhibits "F," "B," and "C," at Drawbaugh's shop under similar conditions; and that only fragmentary or incoherent speech could be occasionally and exceptionally rendered by the reproduced instruments which had been experimented with privately before the public test. The proofs show that all along to 1878 Drawbaugh exhibited his earlier instruments, "F" and "B," to spectators and used them as his talking machine, sometimes showing or using both together, and sometimes one of them. The testimony of the defendant's witnesses,—Springer, Moore, Musser, and Bayler, is pertinent upon this point, and has been referred to. How is it to be explained that he used these crude instruments in 1875 and 1876, as his talking machine, if he had the better instruments, especially such instruments as "E" and "D"? But in view of the fact now shown that these earlier exhibits are incapable of satisfactory articulation, what confidence can be placed in the rest of the testimony produced to identify exhibits? If the witnesses are mistaken in identifying these very characteristic instruments, and in recalling the results obtained through them, little reliance can be placed upon the identification of the other instruments, or upon the statement of the results which the witnesses think were obtained through them. If these witnesses are mistaken in the dates which they fix for the occasions they speak of, their testimony can be reconciled with all the probabilities of the case. And the reasonable explanation of their testimony is, that those witnesses who really saw or used the later exhibits, did so in 1876, 1877, 1878, and later, instead of on earlier occasions.

DRAWBAUGH AN EXPERIMENTER, NOT AN ORIGINAL INVENTOR.

The proofs on both sides lead to the general conclusion that Drawbaugh was not an original inventor of the speaking telephone, but had been an experimenter without obtaining practical results until the introduction of the instruments into Harrisburg. It is very probable that after reading in the *Scientific American*, loaned to him by Mr. Shapley in October, 1876, the article purporting to describe Bell's telephone, but which really describes better the Reis apparatus, he undertook to improve his old devices. At that time, or after he had examined the telephone instruments at Harrisburg, and carried one of them home to study, he may have altered the organization of his instrument, and made the intermediate exhibits between "F" and "D." If he exhibited them at his shop, and was able to transmit speech through them, this fact will account for the testimony of the witnesses who identify these exhibits, and may be mistaken as to the time they saw them. The real history of his talking machine is known only to himself, and it will not be profitable to conjecture when he made the advanced instruments which he claims to have made in February, 1875, and the later instruments.

It may be, that in discrediting his narrative, and rejecting the theory of the facts which rest upon it, the value of the corroborative testimony has been underestimated. However this may be, no doubt is entertained as to the conclusion which should be reached upon the proofs.

SUMMARY OF DEFENDANT'S CASE.

Succinctly stated, most favorably for the defendants, the case is this: One hundred witnesses, more or less, testify that on one or more occasions, which took place from five to ten years before, they think they saw this or that device used as a talking machine; they are ignorant of the principle and of the mechanical construction of the instruments, but they heard speech through them perfectly well, and through one set of instruments as well as the other. This case is met on the part of the complainants by proof that the instruments, which most of the witnesses think they saw and heard through, were incapable of being heard through in the manner described by them, and further that the man who knew all about the capacity of his instruments never attempted to use them in a manner which would demonstrate their efficiency and commercial value, but on the contrary for ten years after he could have patented them, and for five years after they were mechanically perfect, knowing all the time that a fortune awaited the patentee, and with no obstacles in his way, did not move, but calmly saw another obtain a patent and reap the fame and profit of the invention.

TRUTH OF THE DEFENCE OPEN TO FATAL DOUBT.

Without regard to other features of the case, it is sufficient to say that the defence is not established so as to remove a fair doubt of its truth, and such doubt is fatal.

The observation of an eminent commentator may be quoted as apposite to the case: "No form of judicial evidence is infallible, however strong in itself; the degree of assurance resulting from it amounts only to an indefinitely high degree of probability; and, perhaps, as many erroneous judgments have taken place on false or mistaken direct testimony, as on presumptive proof." Best's Ev. Sec. 468.

A decree is ordered for complainant.

REVERBERATIONS FROM THE TELEPHONE DECISION.

The motion for an injunction made by the Bell Telephone Co., against the People's Telephone Co., was renewed in the United States Circuit Court at Trenton, N. J., Dec. 15. When it was originally made several months ago, the court refused it, but gave permission for it to be renewed at any future time. It was urged that the recent decision of the main question justified the granting of the desired injunction. The counsel for the opposing company declared that this was not a final decision of the matter. This is a distinct company from the one which has been engaged in exploiting Drawbaugh, and employs the Hopkins telephone. Judge Nixon reserved his decision.

The United States Telephone Manufacturing company, of New York, and the McDonough Telephone and Telegraph company, of New Jersey, filed a bill in the United States Circuit court at Trenton, Dec. 22, asking for an injunction against the American Bell Telephone company, of Boston, and the Domestic Telegraph and Telephone company, of Newark, for an infringement of certain patents of James W. McDonough of Chicago, Ill., for electric speaking telephones.

THE ELECTRIC RAILWAY SYNDICATE.

The fifth of the series of meetings for the purpose of uniting the different electric railway interests was held in this city December 16. It was decided that all the parties who are to come into the American Electric Railway Co., must agree to transfer to that company all their patents and inventions for electrical propulsion on railways in the United States, as a condition precedent to participating in the advantages of this arrangement, they to be compensated by participation in the stock reserved for patents and inventions, in the proportion fixed by the arbitrators.

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Sir William Thomson, of Glasgow University; Prof. Charles R. Cross, of the Massachusetts Institute of Technology, and President Harris, of the Northern Pacific Railway, have accepted invitations to be members of the Expert Commission to test the rival electric motors on the Second avenue elevated railway, and apportion the stock of the new company among the companies consolidating, according to the value of their respective motor patents; and it is believed that President Roberts, of the Pennsylvania Railway, and President Rutter, of the New York Central Railway, will also accept. It is understood that the commission will be empowered to employ expert electricians and practical mechanical engineers to conduct the test, under its direction, and its members will render a verdict upon the results of the experiments.

At a subsequent meeting held Dec. 22, it was decided to issue an invitation to all reputable holders of patents relating to the subject of electric railroad propulsion, to assign the exclusive rights under their several patents for electric railroad purposes to the new company, and to receive from the board of arbitration their proportionate share of the stock according to the value of such patents. Those who do not avail themselves of the offer before December 31 are to be excluded from the advantages of the arrangement.

STATE TAXATION OF TELEGRAPH COMPANIES.

Under the corporation law of New York state passed in 1881, the Controller desires to levy a tax on the entire capital stock of the Western Union, the Gold and Stock, and other telegraph companies. The companies are resisting the payment of the tax, arguing that only that proportion of their property represented by stock in this state should be taxed. The Gold and Stock Telegraph Co., makes the point that the State has no right to tax property not within its limits, as it would do if it taxed the entire capital stock of the company. In the lower courts the judges have decided against the companies. Nearly $500,000 is involved in the two cases.

General Wager Swayne and Matthew Hale appeared for the telegraph companies and Attorney-General O'Brien for the people. General Swayne claimed that by a law passed in 1853 telegraph companies should be taxed only on that part of their capital covering property in this state. This law was not repealed by the corporation tax law of 1881. In his brief he quoted from many authorities. The Attorney General in his reply argued that the law of 1881 already gave the State the right to tax all the capital stock and that the act of 1853 was repealed by that of 1881. The judges, as usual, took the briefs and reserved their decision.

DISSOLUTION OF THE TELEGRAPH POOL.

The pooling arrangement under which the Bankers and Merchants' and the Postal Telegraph companies have been doing business since the retirement of the Baltimore and Ohio Telegraph Co. from the celebrated tripartite agreement, was dissolved December 11 by mutual consent as well as by necessity. The Bankers and Merchants', although in a receiver's hands, has been in great financial distress. It is stated that a complete separation of business interests at stations where the offices of the two companies have been mutually conducted will be arranged within a few days.

The receipts of the Bankers and Merchants' Co. have not been sufficient to enable the receivers to meet the interest due on the large bonded debt. While the employés have waited months for their pay, business has been falling off, until the hopelessness of struggling to maintain the united lines was apparent.

PRINTING TELEGRAPH PATENT SUIT.

Before the U. S. Circuit Court at Hartford, Dec. 23, Judge Shipman on the bench, a hearing was had on a motion for a preliminary injunction in the case of the Gold and Stock Telegraph Co. against the Commercial Telegram Co., in a suit concerning the right to use the Field printing instrument, it being claimed that this is an infringement upon the patents of E. A. Calahan, owned by the complainant company. Dickerson, Thurston and Dickerson appear for the plaintiff, and Roscoe Conkling and General S. A. Duncan for the defendant.

AUTHORIZED TO ISSUE RECEIVERS' CERTIFICATES.

Counsel for the Receivers of the Bankers and Merchants' Telegraph Co., made application to the United States Circuit Court to have confirmed an order made by the Supreme Court of New York permitting the Receivers of that company to make a settlement with the Receivers of a construction company which had constructed property for the telegraph company. Under the arrangement the Bankers and Merchants will receive the property so constructed, and issue Receivers' certificates in payment therefor, which will be secured by a lien on the property in question. Judge Butler confirmed the order on Dec. 9th, so far as issuing Receivers' certificates to the amount of $130,000, but refused permission for the issuance of $20,000 worth additional which had been asked for.

ELECTRIC LIGHT AND POWER.

Domestic.

Easton, Penn., is lighting its streets with electricity.

At a recent public meeting at Toronto, Mr. James French said that "the electric light which we were promised would be cheaper than gas, was about three times as expensive."

For some weeks Delaware avenue, between Market and Vine streets, Philadelphia, was in almost total darkness, as the electric lights were not lighted. The cable is laid underground, and it is said the insulation was burned off in places. Finally Mayor Smith instructed the police to light the gas lamps, which was done, and it is said will be continued until further orders.

The electric lighting apparatus on the dome of the court house, at Wabash, Indiana, was wrecked on the night of October 22d, by a flock of wild geese.

The prospects are that Laconia, N. H., will soon be furnished with electric lights. A preliminary meeting has been held and $1,500 in stock subscribed, and upwards of 100 lights engaged by merchants and others. Local parties are interested in the enterprise. They have secured excellent power and expected to have the lights in operation December 20.

The managers of the New Orleans Exposition have awarded the following contracts for lighting the buildings and grounds: The Leavitt-Mueller electric light, 800 arc lamps for the main buildings; the Brush electric light, 300 lamps for the Government and State exhibit building; the Jenney arc light, 100 lamps, with five iron towers for the grounds and the live stock department; Thomson-Houston, 100 arc lights for the machinery, extension and saw mill; Edison incandescent light, 4,800 lights for the Music Hall, Horticultural Hall, the Art Gallery, State head-quarters, and offices. Each principal entrance and wharf will be lighted by six Leavitt-Mueller lamps; altogether 1,500 h. p. is required for the electric lights which cost the Exposition over $100,000.

A corporation has been formed under the laws of Massachusetts, entitled the Holyoke Electric Light and Power Co., Wm. A. Chase, Pres., R. C. Winchester, Treas. Capital $10,000.

A company has been formed in Bangor, Maine, with a capital of $50,000 for establishing a central lighting station to supply the city and people there with arc and incandescent electric lights, as well as electric motors for transmission of power.

The Brush Electric Light works, at Toledo, O., were damaged by fire on November 19th to the extent of $10,000.

Foreign.

An Electric Lighting company has lately been formed in Madrid, with a capital of £102,000, for the purpose of establishing in that city a central station, from which 12,000 incandescent lamps may be supplied. The works, to be erected near the Puerta de Salamanca, will comprise 15 Belleville or de Naeyer 100 h. p. steam-boilers, and two Sulzer or Corliss engines of 1,000 h. p. The electric machines to be erected are two Gordon dynamos, which will supply 10,000 ampères with an electromotive power of 120 volts. The current is to be distributed by means of underground cables in accordance with Edison's system.

The British Gaslight Co. has given the Town Council notice of its intention to raise the price of gas in its Hull district on and after the 1st of January. This step, attributed to the discontinuance of the electric lighting, has given much dissatisfaction. A special committee has been appointed to consider it.

A meeting of the Edison and Swan United Electric Light Co. (Limited) was held, November 11, in London. Mr. J. S. Forbes presided, and in the course of his remarks said that, including the item of depreciation, £2,310, the loss on the year's operations had been £28,214. They had had, roughly, £300,000 locked up, to represent which they had their patents, a first-rate manufactory, and a trained establishment. For the first three months of the current year's operations there had been a balance of profit of £752, or at the rate of £3,000 a year. It was their intention to do no more speculative business, either street, house to house, or any other lighting, but only that which paid.

The status of electric lighting in Australia, is given by Mr. McLean of Melbourne as follows:

Of the electric light there is very little to be said. Some efforts have been made, especially in Elizabeth street, Melbourne, one of our principal streets, but it was not a success, and all efforts on a large scale have been abandoned. There are a few lights kept

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going in some of the theatres, but what it costs I cannot say, except that I believe that the managers will not pay more for it than they have to pay for gas, and so I presume it is kept on there as a kind of standing advertisement. The belief in the colony is the same as that in England, viz., that electricity as a light is only yet in its infancy, and with this conviction there does not seem a disposition to help the problem forward

The Great Eastern before leaving England for the New Orleans Exposition, is to be fitted up throughout with incandescent lamps.

MANUFACTURING AND TRADE NOTES.

The Westinghouse Machine Co., of Pittsburg, has received an order from Scotland for a steam-engine for use in one of the ironclads of the British Navy. It will operate the electro-dynamo on each ship from which light is obtained for incandescent lamps throughout the vessel, arc lights for signal or danger lights, and the enormous search light at the masthead.

The Electrical Supply Co., of Ansonia, Conn., has opened an office and wareroom at 175 Lake street, Chicago. A full line of electrical goods, such as electrical wire, carbons and general supplies, will be kept in stock.

MISCELLANEOUS.

The Underground Electric Co., with a capital of $25,000, has been incorporated in New York by Joseph B. White and Henry Franz.

The Sims Electric Torpedo Co. has been incorporated in New York with a capital of $1,000,000. The corporators are Oscar Marshall, Henry P. Butler and Richard C. McCormick. Their purpose is to manufacture torpedoes, torpedo boats, submarine vessels, war ships and other materials of war.

The following electrical companies have been incorporated in Illinois: The Illinois Pan-Electric Co., capital stock, $1,000,000; incorporators, Porter White, John Boyle, and L. M. Chipley. The Globe Electric Engineering Co., capital $200,000; incorporators, Herbert A. Streeter, proprietor of the Globe Iron Works; Henry Burkholder and George W. Wilbur.

The American representative of Marcus Ward & Co., British paper manufacturers says: "An experience of twenty-five years in the manufacture of paper has convinced me that climate has much to do with the quality of fine writing papers. You may have as good mills and workmen as England, but your climate changes so suddenly and violently that the greatest care in the process cannot provide, say, for the different amount of sizing that must be put in the pulp, and that varies with the weather. Every English workman in an American paper or cotton mill will tell you that the electricity in the air in this country is much more intense than it is over the water. So much so, indeed, that special apparatus is made to correct its influence about a machine. English writing paper is largely used in the United States. In Washington I supply the various departments and the White House with our paper."

PERSONAL MENTION.

Hon. George Walker, who was appointed Consul General to France under the Hayes administration, is now in this country. He was formerly a vice-president of the Western Union and more recently of the Gold and Stock Telegraph Co.

A press despatch from Washington says that "It is probable that Mr. H. D. Lyman, Second Assistant Postmaster General, will resign his office within a short time to accept a position with the Bell Telephone Co."

THE TELEGRAPH.

The war of rates was inaugurated in the interior of New York state last month by the Baltimore and Ohio company reducing from 25 to 20 cents to points within the state.

Minneapolis has a district telegraph system which has some peculiar features. It does a general parcel, package and trunk delivery business, keeping several wagons constantly employed. This began in a small way by employing boys to carry bundles. The business men in the retail line found them very useful in the delivery of purchases to customers, and at length the work became so large in volume that the use of teams was necessary.

A larger business is done by telegraph companies in the United States than in any other country in the world. Over 40,000,000 messages were sent last year. Great Britain sent nearly 33,000,000, France 26,000,000, and Germany 18,000,000. The total for the world was 153,000,000, fully one-half being sent in English-speaking countries. Germany has nearly as many telegraph offices as the United States, although so much smaller in area, and doing less than half the business. Great Britain, on the contrary, does a large business with comparatively few offices.

The Houston and Texas Central Railway Co., applied to Judge Hartley, of the Texas State Court, for an injunction against the Baltimore and Ohio Telegraph Co., to restrain that company from constructing its lines on the right of way of the railway company in Collin County. Judge Hartley refused the injunction, and the telegraph line upon the right of way of the railway company is completed.

The local telegraph service within the Paris fortifications was to be performed entirely by pneumatic tubes after December 15th.

In the United States Circuit Court at Norfolk, Va., Dec. 5th, Judge R. W. Hughes presiding, a bill was filed by William Mahone, suing for himself, and others similarly situated, as a bondholder and stockholder of the Southern Telegraph Co., charging fraud, waste, mismanagement, and insolvency on the part of the officers of said company, and praying for an injunction, the appointment of a receiver, and the winding up of the company. The litigation involves bonds amounting to $2,500,000. A temporary restraining order was granted by the court, the Marshal was ordered to take custody of the affairs of the company, and the case was set for further proceedings on Dec. 19. It is stated that the franchise of the company is a valuable one, and under proper management it could be made not only solvent but profitable. The company is in default for interest, and, it is said, in danger of irreparable bankruptcy.

FINANCIAL.

Sheriff Johnson sold at public auction, at Petersburg, Va., Dec. 19, $19,500 of the Southern Telegraph Company's bonds, of the denominations of $1,000, $500 and $250, at the rate of $17 per $100.

The Western Union directors met December 10 and adopted the following report of the Executive Committee:

The following statement will show the condition of the company at the close of the quarter ended September 30, 1884:

Surplus July 1, 1884, as per last quarterly report		$4,157,468 89
Net revenues quarter ended September 30, 1884		1,545,529 17
		$5,702,998 06
From which, deducting appropriations for—		
Dividend of 1¼ per cent., paid October 15	$1,399,807 49	
Interest on bonded debt	124,000 00	
Sinking fund	20,000 00	
		1,543,807 49
Leaves a surplus, October 1, of		$4,159,190 57
The net revenues of the quarter ending December 31, instant, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, will be about		$1,500,000 00
Add surplus October 1, as above		4,159,190 57
		$5,659,190 57
From which, appropriating for—		
Interest on bonded debt	$124,000 00	
Sinking fund	20,000 00	
		$144,000 00
Leaves a balance of		$5,515,190 57
It requires for a dividend of 1¼ per cent. on the capital stock		1,199,837 00
Deducting which leaves a surplus, after paying dividend, of		$4,315,353 57

In view of the preceding statements, the committee recommend the adoption by the board of the following:

Resolved, That a dividend of 1¼ per cent. on the capital stock of this company be hereby declared, payable on and after the 15th of January next, to stockholders of record at the close of the transfer books on the 20th of December, instant.

Resolved, That for the purpose of the dividend hereby declared, the stock books of the company in New York and London be closed at 3 o'clock on the afternoon of the 20th of December, instant, and be reopened on the morning of the 2d of January next. NORVIN GREEN, President.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 59 *Wall Street, New York city.*

LEGAL NOTES.

Supreme Court of the United States.—The case of *Butterworth*, Commissioner of Patents *v. The United States ex rel. Hoe et al.*, decided November 3rd, 1884, involves important questions as to the right of appeal from the decision of the Commissioner of Patents to the Secretary of the Interior. The history of this case is briefly as follows:—A patent was granted to one Scott,

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March 18th, 1881, for a printing machine. An application was filed by one Gill, March 12th, 1881, for a similar invention. An interference was declared between Gill and Scott, which was heard by the Examiner of Interferences and decided by him in favor of Scott, and on appeal to the Examiners in Chief, the decision was affirmed. An appeal was taken to the then Commissioner, Marble, who, after argument, decided the case in favor of Gill. No motion either for a new trial or a rehearing was made before the Commissioner, but an appeal was taken by Scott to the Secretary of the Interior. While the case was pending before the Secretary, counsel for Gill made a demand upon the present Commissioner, Butterworth, for a patent to issue, based upon the decision of Commissioner Marble that Gill was the first and sole inventor. Commissioner Butterworth refused so to issue the patent, whereupon Gill, through his counsel, filed a petition for a writ of mandamus against the Commissioner to compel him to issue a patent to Gill in accordance with the judgment of his predecessor.

A rule was made requiring the Commissioner to show cause why the writ should not issue against him as prayed for. In answer to the rule, the Commissioner reviewed the history of the case, admitted that a judgment in favor of Gill had been entered in the interference between him and Scott, which was unreversed, and that no motion or other proceeding was pending in the office to review or modify that finding. The Commissioner further stated that he did not desire to hear further argument in the case, nor to make any other or additional inquiry or investigation in that behalf; that he refused to issue the patent on the sole ground and for no other reason than that the case had been appealed to the Secretary of the Interior; that if the honorable Secretary had jurisdiction to hear and determine the case on appeal, refusing to issue the patent as demanded by Gill was proper, otherwise it was not, and Gill was entitled to have his patent issue to him as prayed. Upon this return issue was joined. The case was heard by the Supreme Court of the District of Columbia, and a writ of mandamus against the Commissioner awarded. The case was then taken on appeal to the Supreme Court of the United States. The Supreme Court held that mandamus will not lie to compel a public officer to do a particular thing which his superior in authority has lawfully ordered him not to do. The court also held that in all matters in which the action of the Commissioner is judicial or quasi-judicial, the fact that no appeal is expressly given to the Secretary is conclusive that none is to be implied, and this is equally true whether or not an appeal is allowed to the courts; that the supervision conferred upon the Secretary by the statute does not authorize him to substitute his discretion and judgment for that of the Commissioner when by law the latter is required to exercise his own, and when that judgment, unless reversed in the special mode pointed out by judicial process, is by law the condition on which the right of the claimant is declared to depend. *Morris et al.* v. *McMillin.* This was an appeal from the Circuit Court of the Western District of Pennsylvania. The original bill was filed to restrain appellants from infringement of patent dated April 16th, 1867, for an improvement in applying steam-power to the capstans of steamboats. The Supreme Court reversed the decree of the Circuit and remanded the case with directions to dismiss the bill, on the ground that the patent was void for want of patentable invention, the only field of invention left for the patent to cover being the application by the old and familiar arrangement of shafts and cog-wheels of the power of an auxiliary engine to a capstan instead of a windlass.

United States Circuit Courts.—*Odell et al.* v. *Stout et al.* Suit for infringement brought in the Southern District of Ohio, alleging infringement of reissued patent for roller-mills. SAGE, J., held, MATTHEWS, J., concurring, that the grant of a reissue is *prima facie*, but not conclusive evidence of inadvertence, accident or mistake. Claims in the reissue for patentable parts of the combination in the original, do not invalidate the reissue if the patentee is first inventor of the patentable parts claimed, although the original was for the combination alone; therefore a patentee may under proper circumstances extend his claims by reissue to the limits of his invention, but he may not enlarge the invention. Upon the authority of *James* v. *Campbell*, and other decisions of the Supreme Court, it is clear that the claim may be enlarged by reissue if the patentee moves promptly and no rights of others have intervened. What constitutes a reasonable time must be decided by the Court upon the case presented. The rule is equitable and therefore flexible and to be applied according to equity. The rule that an invention may be exhibited either in a drawing or model so as to lay the foundation of a claim for priority, is to be taken with the qualification that it must be followed up with reasonable diligence. Patents granted between the making of a drawing by complainant and his filing an application a year afterward, are not anticipated by such drawing. One claim in a reissue may be void without necessarily invalidating other claims, provided the latter were made in good faith. Where it appears that reissued claims were intended to broaden the invention and thereby cover intermediate inventions, the fraud may be sufficient to vitiate all the claims. *Hatch* v. *Adams.* This was a case in the Eastern District of Pennsylvania, involving a single question, viz.: Has a purchaser of patented articles from a grantee that has an exclusive right to manufacture and sell under the patent in a specified part of the United States, the right to sell the articles in the course of trade outside the designated limits of the grant? MCKENNAN, J., decides this question in the negative.

United States Patent Office.—In *Gill* v. *Scott*, a rehearing was asked for by counsel for Scott. The state of facts in this case is set forth in the report of the decision of the U. S. Supreme Court given above. After the rendition of the judgment of the Supreme Court of the District of Columbia, but possibly before the opinion of the Supreme Court of the United States was announced, counsel for Scott moved for a rehearing on the record. BUTTERWORTH, Commissioner, says that after a case has been heard and decided by the Commissioner it is competent for either party to move for a rehearing on the record. When, however, instead of making such motion the party prosecutes an appeal; Held, that the prosecution of such an appeal operates as a waiver of the right to subsequently make such motion. Also, the case having been decided by a former commissioner, it would be obnoxious to rule 139 for the present Commissioner to rehear it, no new facts having been presented to him. The motion was accordingly overruled. In *ex parte Wilkin*, which was an appeal from the primary examiner, who objected to the language of applicant's claim on the ground that it was vague and did not identify the construction which performed the result desired, referring to *ex parte Deming* (26 O. G., 1,207), and *ex parte Holt* (29 O. G., 171), Acting Commissioner DYRENFORTH held that a claim which mainly depends upon such language as "mechanism, substantially as described" to define the invention sought to be patented, is vague and indefinite and does not comply with the statute. In *ex parte Chapman*, it appeared that the last action of the Patent Office in applicant's case was made August 28th, 1882, which therefore became abandoned on August 28th, 1884. The applicant now petitions to be allowed to renew the application under the provisions of section 4,894 R. S. It appeared that applicant's attorneys, who reside in Chicago, put the case into the hands of their Washington associate on August 18th, and that an amendment was prepared by him before the two years expired, but was not filed in time because of his absence from the city. BUTTERWORTH, Commissioner, denied the petition, on the ground that the discretion vested in the Commissioner by the statute is judicial discretion and not mere complaisance, and hence satisfactory evidence must be adduced that the delay could not have been avoided, which in this case did not appear. *Ex parte Lassells.* This was an appeal from the action of an Examiner who refused to accept an amendment cancelling all the claims of an applicant without substituting others. The Examiner held that the cancellation of all the claims, being in effect an abandonment, should be framed in such manner as to make that intent clear. BUTTERWORTH, Commissioner, held that while the question is not free from doubt, claims would seem to be indispensable to the life of the application. The cancellat on of all claims signifies intent to abandon. Whether the applicant shall be required to put that abandonment in set words is a matter within the discretion of the office. The Examiner's action was approved. *Ex parte Witty* and *Caffrey.* Appeal from the action of the Examiner, who required an applicant to amend his drawings so as to show a modification of the invention referred to as a mechanical equivalent. BUTTERWORTH, Commissioner, held that the requirement of the Examiner came within the rule of *ex parte Howe* (25 O. G., 1,189) and it was therefore approved.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From November 25 to December 16, 1884 (inclusive).

Alarms and Signals:—*Time Detector*, A. Lasmoles, 308,416, Nov. 25. *Signaling Apparatus*, M. Toulmin, 308,533. *Call box*, C. Herrmann, 308,897, Dec. 9; W. B. Palmer, 308,922. *Low-water Detector*, J. M. Palmatier, 308,979; C. H. Wickersham, 309,425, Dec. 16.

Clocks:—C. H. Pond, 308,521, Nov. 25; same, 308,793, Dec. 2. *Synchronizing Device*, H. L. Bailey, 308,731; W. F. Weisgerber, 309,269, Dec. 16. *Apparatus for Setting Clocks Synchronously*, J. E. Smith, 309,000. Dec. 9, same, *Circuit Controller for Clocks*, 309,001.

Conductors, Insulators, Supports and Systems:—*Underground Conduit*, E. J. Houston, 308,612, Dec. 2. *Electric Light Conductor for Structures*, J. H. Vail, 308,713. *Brace for Telegraph and Telephone Lines*, A. H. Arnold, 308,818. *Insulating Compound and Application*, W. D. Grimshaw, 308,890, Dec. 9. *Wire Supporter*, O. M. Draper, 308,954; A. S. Weaver, 309,267, Dec. 16. *Accessible Underground Conduit*, W. K. Platt and G. A. Aldrich, 309,091. *Adjustable Resistance for Circuits*, F. J. Sprague, 309,167. *Method of Making Cables*, W. R. Patterson, 309,244, Dec. 16. *Ventilating Underground Test Stations*, same, 309,245. *Electric Light Conductor*, same, 309,246. *Joint for Lead Pipes*, same, 309,247. *Apparatus for Maintaining Connection with a Moving Instrument*, C. W. Williams, G. S. Barnum and E. B. Ives, 309,274. *Compound Wire*, F. Chillingworth, 309,439; W. Paul and T. J. Wood, 309,509. *Manufacture of*, I. A. Kilmer, 309,468. *Insulating Wires*, M. D. Fenner, 309,450.

Dynamo Machines and Motors:—*Motor*, G. Trouve, 308,534, Nov. 25; A. D. Blodgett and J. P. Tirrell, 308,548. *Armature Core for Dynamo*, F. K. Fitch, 308,601, Dec. 2. *Dynamo*, E. B. Cutten, 308,832. *Armature for*, B. F. Orton, 308,851.

Galvanic Batteries:—I. L. Roberts, 308,992, Dec. 9.

Ignition:—*Fire Arm*, R. S. H. Thompson, 309,262, Dec. 16.

Lamps and Appurtenances:—*Double Carbon Lamp*, J. A. Dalzell, 308,595, Dec. 2. *Electric Light Fixture*, J. H. Vail, 308,712. *Arc Lamp*, N. McCarty, 308,620; S. F. Van Choate, 309,012, Dec. 9; T. L. Kay, 309,392, Dec. 16; H. A. Gorn, 309,454.

Measurement:—*Gage*, J. and H. M. Goodman, 308,487, Nov. 25; C. D. Warner, 309,114, Dec. 9.

Miscellaneous:—*Means for Locating Mineral Veins*, A. P. Lighthill, 308,908, Dec. 9. *Movement Cure Apparatus*, M. G. Farmer, 309,036. *Educational Apparatus*, I. S. Kinch, 309,064.

Railway Appliances:—*Car Uncoupler*, J. D. Reed, 308,432, Nov. 25. *Apparatus for Controlling Railway Signals*, J. T. Hambay, 308,492. *Circuit Closer for Railway Switches*, same, 308,493. *Apparatus for Controlling Railway Appliances*, same, 308,494. *Railway Signal*, J. L. V. Tepes, 308,845, Dec. 2.

Storage Batteries:—*Making Electrodes for*, W. E. Case, 309,293, Dec. 16.

Telephone Systems and Apparatus:—*Combined Telephone and Automatic Fire Alarm System*, T. D. Lockwood, 308,566, Nov. 25. *Mechanical Telephone*, I. F. Tucker, 308,582. *Arm Rest for Telephone Users*, J. M. Fitch, 308,660, Dec. 2. *Transmitter*, W. H. Eckert, 308,956, Dec. 9; G. T. Woods, 308,817, Dec. 2. *Spring-jack Switch*, R. V. Freeman, 309,218, Dec. 16. *Telephone Apparatus*, T. J. Perrin, 309,357. *Telephone*, J. Lowth, 309,474, 309,475, 309,476.

Telegraphs:—*Polarized Relay*, W. B. Harvey, 308,610, Dec. 2. *Reed for Harmonic*, F. W. Cushing, 308,751. *Dynamo Multiplex*, S. D. Field, 308,835. *Telegraphy*, R. K. Boyle, 309,126, Dec. 9. *Winding Telegraph Paper*, H. F. Clarke, 309,332. *Printing Telegraph*, F. L. Pope and T. A. Edison, 10,542, reissue, Dec. 9.

Expired Patents:—A list of the more important electrical patents which expire during the current month is subjoined:—J. L. Arman, *Submarine Cable*, 73,847, Jan. 21. J. H. Bunnell, *Telegraph Repeater*, 73,774, Jan. 28. F. Bean, *Electric Gas-Lighting Apparatus*, 73,868, Jan. 28. S. G. Cabell, *Preventing Incrustation of Steam Boilers*, 73,872, Jan. 28.

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NEW YORK, FEBRUARY, 1885.

RUINOUS TELEGRAPHIC COMPETITION.

THE country is now passing through an era of excessive competition in various branches of industry. Within reasonable limits this heroic process of reaching a lower strata of prices might be considered a healthy indication, but pursued as it now is in many instances, to a point far below the actual cost of service or production, this course, if persevered in, means that the weakest must surrender, and that by devices familiar to the managers of great corporations, the employees must be taxed at present, and the public in the future, to pay for the follies of the management in the past. Those who have watched the coming in and going out of various electrical enterprises, are well aware that competition in this field has, in repeated instances, produced hardship and bankruptcy, leading, in some individual cases, to financial ruin, insanity and death. Even in the hey-day of apparent prosperity the managers of these various rival institutions are harassed by the continually increasing burden of their responsibilities, yet they toil on and on unremittingly, until the bubble inflated to its last extremity finally bursts, leaving behind it a trail of wreckage, which is scarcely removed from view before the vacancy caused by its disappearance is filled by a new aspirant for—what? It is barely possible that certain promoters are sometimes individually benefited. Years ago, one of the builders of the old Bankers and Brokers' line was heard to say that he had made $250,000 out of his contract, which was all the money he wanted, and he had decided to retire. A quarter of a century has elapsed and he has not since appeared in the arena, but he at least attained the unusual notoriety of having been satisfied with his accumulations, and if the world owed him a living the account has been settled.

By the business system and tariff now prevailing, the patron of a telegraph company may have a district call-box placed in his office free of charge, a book of blanks furnished, a messenger sent to his office for a telegram as required, which will be delivered to his correspondent in Chicago, a distance of 1,000 miles, for *fifteen* cents.

Contrary to the popular supposition, there are no improved methods of telegraphing in use which warrant so low a rate. To assert that the business public demands or even expects such a concession in prices is an absurdity. A really good telegraph service is certainly deserving of a fair profit; a profit which should cover the cost of substantial lines and of fairly paid, intelligent and contented employees. There is a certain class of messages which are promptly transmitted and delivered, but the general service is, as everyone knows, by no means perfect in all its branches. Within a few days we have seen the complaint that a telegram was handed in at the Broad street, Philadelphia station, for transmission to Harlem in this city, at 4.30 P. M. The sender started home by the 5 o'clock train, and reached the destination of his despatch half an hour before its arrival. While this delay may not have been caused by cheap rates, such examples, which are by no means infrequent, have led us to believe that the public has really needed a better service at the old rates, far more than it has a non-remunerative tariff, which tends to superinduce economical measures, really detrimental to what should be a business demanding the highest degree of efficiency in every department.

The words of William M. Swain, a pioneer in the telegraph business, are as true to-day as when they were spoken at a convention in 1853:

"There is too much cheapness and looseness in all departments of the telegraph service. Why don't your lines pay? Why is it that we hear of companies going into debt and pleading poverty? Why are there, on some lines, a set of boys, without a thought of responsibility resting upon them, intrusted with and undertaking to do a business of vast consequence, and often involving so fearful results to individuals? It is because you have *belittled* your business. . . . You take a message involving thousands of dollars, transmit it for *ten cents* (uttered disgustedly), and deliver it free, and think you have done a meritorious public act! And then, having no profits, you come with long faces, and want help, instead of doing business at living rates like sensible men."

ISOLATED ELECTRIC LIGHTING PLANTS.

THE London *Engineer* notes that about 1 per cent. of all the gas used in New York, or about 55 million feet annually, is used in 30 (?) of the largest theatres. This, it adds, at 8s. per M., ought to offer electricity a fine field. Although the price of gas in New York city has been reduced from $2.25 to $1.75 per 1,000 feet, the complaint is quite general that gas bills average higher than before. Whatever basis there may be for such assertions, it certainly appears as if there was an extensive field in this city for private incandescent lighting, which might be profitably developed by such companies as make a business of selling or leasing isolated plants. No building of any pretensions is now constructed which does not require the services of an engineer who has charge of the elevators and steam-heating service. No man should be employed for such work who is not competent to take charge of the necessary dynamo machines for a small electric light plant

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especially in a city where a competent expert may be had at short notice in case of any unusual difficulty.

So many large office buildings are being placed in the market, that the competition for desirable tenants is likely to be quite active, and as steam heat is already provided, nothing more attractive could be added to promote the comfort of the occupants than an outfit of first-class incandescent electric lights. In many cases, no doubt, such a system might be extended to adjacent buildings on the same block not provided with the requisite steam appliances. This would so localize the service as to avoid the use of long, and consequently expensive underground conductors. Without denying the ultimate commercial practicability of a centralized system, it is obvious that, in order to supply a district radiating even half a mile in each direction, there must be a very large sum of money invested to provide conductors of the requisite capacity, while every foot used in carrying it past the property of non-consumers must bring an additional tax upon regular customers, making the total cost of the service more than it really should be. Given, a building where a steam plant already exists; or better still, where the original steam plant is planned with a view to running a local electric lighting system, it appears feasible to compete commercially with gas on any basis which the venders of that illuminant are likely to establish. Indeed, the comparative safety of the incandescent system is now so generally acknowledged, that its adoption for the lighting of theatres, hotels, asylums, and, in fact, all buildings where large numbers of people are congregated, might be a very proper provision for legislative enactment. While such action might be questionable, however, as being in the interest of certain corporations, there can be no objection whatever to a rebate by insurance companies in favor of buildings lighted in this manner, especially where fitted up in accordance with the regulations of the Board of Underwriters.

DEATH-IN-THE-AIR LEGISLATION.

The impending experimental trial of electric motors with a view to the displacement of the objectionable steam locomotives on the elevated railways has led us to the conclusion that upon the definite adoption of electricity for this purpose by the Manhattan Railway Company, a movement should be immediately made in the interests of the public toward placing these lines of transportation underground, where they ought originally to have been constructed. The conditions under which the elevated railway corporations were granted the privilege of occupying our principal thoroughfares have undergone material change. It is extremely problematical whether the nuisances which have been endured by property owners and by the public generally could have been foreseen or predicted by the most violent opponents of these schemes. To avoid the expense of purchasing or leasing adjacent property for station purposes, they have built their straggling structures—many of them painted green—at important street corners, thus depriving valuable business property of the light and air to which all persons are justly entitled under the common law.

The numerous and conclusive arguments with which we are all so familiar, against overhead electrical wires, are even more applicable to the elevated railways. As an obstacle in the way of firemen performing their hazardous duties, this formidable framework of iron stands practically immovable and indestructible. When surmounted by electrically charged rails the state of affairs will be incomparably worse. Thanks to the missionary efforts of the daily press, ably seconded by Professors Johnson, Bell, and other well-known experts, the community at large have become thoroughly awakened to the obstructive, unæsthetic and life-destroying qualities of aerial electric conductors. The general public, the firemen, and even the policemen, cannot but stand in awe of a structure, to touch or even to lean against which will, as they well understand, be followed by instantaneous death. Even in case electricity is not adopted for propelling the elevated trains, pedestrians and horses ought no longer be subjected to the danger and discomfort of an unintermittent shower of live coals, hammers, bolts, nuts, oil, and tobacco juice. Local steam transit has proved, from a financial point of view, to be a complete success. The elevated railroad corporations have been permitted to use the streets of the city for a sufficient length of time for experimental purposes, and now that they have demonstrated their earning capacity, public opinion must be manufactured of a sufficiently high potential to compel them to place their tracks underground. This has been successfully done in London, and while the cost is, without doubt, considerable, it has not prevented such railways from being operated at a profit. As in the case of the telegraph lines, various objections will be raised by monopolists and other interested parties against making the change, such, for example, as the disturbance of sewerage, gas and water systems, etc., but the resources of modern engineering will be found quite able to overcome all such objections, provided a sufficient allowance of money is appropriated for the work. We do not profess to be experts in engineering problems, but we venture to suggest that, if necessary, the sewers might be removed to the surface of the streets, as has been done with apparent success in Philadelphia, Pa., Paterson, N. J., and some other American cities. Although the original outlay consequent upon the construction of the underground railways would be large, yet when the expense of maintenance and the questionable permanency of the present structures are considered, no intelligent person can for a moment doubt that subterranean railways would in the end prove the most economical. It appears to be very doubtful whether the present railway lines will be of sufficient capacity to meet the demands of the traveling public for more than five years longer, therefore it is important that steps should be immediately taken to prevent, by appropriate legislation, the possibility of any further encroachments upon the vested rights of the people. The underground telegraph bill passed by the state legislature last year is very well so far as it goes, but is defective in one important respect, as its author inadvertently failed to include a specific clause prohibiting overhead electric conductors other than wires or cables, and as in the use of electricity for railway purposes it is the evident intention to utilize the rails, and for aught we know to the contrary, the entire structure, as a path for

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the death-dealing electric current, it will be necessary to amend the act accordingly. It appears to be the general opinion that an attempt will be made by interested parties to amend the act in any event, as, according to its present provisions, the use of electrical apparatus of any kind anywhere above ground is absolutely prohibited, and since the modern fashion of placing business offices in the upper stories of high buildings has come into vogue, it is perhaps not unnatural that some opposition should be made by their occupants against the relegation of their telephones and district call-boxes to the sub-cellars. Still it is doubtful whether a comparatively slight inconvenience of this kind entailed wholly upon private parties should be permitted to stand in the way of a great public reform. It is rumored that a powerful secret movement in favor of the repeal of the present law has been organized by certain prominent capitalists who control the lightning-rod business, on the ground that even spiral twist conductors with gold-plated tops, fail to perform their functions when buried in the earth, and that this interest even hints at the possibility of retaliatory legislation, which will compel the Edison Illuminating company to dig up their conductors and place them on poles. We sincerely hope that no such foolish measures will receive countenance and support in an enlightened community like ours.

PRINTING TELEGRAPH LITIGATION.

The Gold and Stock Telegraph Company was organized in 1867 for the purpose of operating a system of printing telegraphs for reporting the quotations of the gold and stock exchanges in New York city, under patents of Edward A. Calahan. During the eighteen years which have elapsed since that date, this business has become very widely extended and correspondingly profitable. This company has from time to time acquired a large number of patents relating to their particular line of business, but the original patent of Calahan for a method and apparatus for printing the quotations in two lines on one strip of paper has always been regarded as one of the most important and valuable. No serious attempt to infringe this patent or to put into actual use an apparatus producing a similar result was made until within a few years, when a suit was brought against one Charles J. Wiley, who had constructed a number of printing instruments of this character, which resulted in favor of the complainants.

In the spring of 1883, the Gold and Stock company filed a bill in equity in the Circuit Court of the United States, asking for an injunction against the Commercial Telegram Company, an organization formed in this city for the purpose of carrying on business in competition with the Gold and Stock company, and employing a printing instrument invented by Stephen D. Field, which produced a record in two lines similar to that of the Calahan instrument. Judge Shipman handed in a decision on January 13th, 1885, denying the motion for an injunction. As this case has excited considerable interest in electrical circles, we have printed the decision in full in another column.

The Calahan patent will expire on April 21, 1885, and the decision of Judge Shipman must be regarded as a substantial victory for the Commercial Telegram Company, as the operation of their instruments cannot now be interfered with before the expiration of the patent, and of course not afterwards, whatever might be the result of an action for damages on the merits of the case. If, on the other hand, a preliminary injunction had been granted, the operations of the Commercial company would have been brought to a stand still during the remainder of the term of the patent, which would necessarily have had a most disastrous effect upon their business.

TELEPHONIC LITIGATION.

The American Bell Telephone Company has scored another legal victory, having obtained a favorable decision in their suits against the Overland Telephone Company for infringement of the Bell patents. It will be recollected that an injunction in this case was refused some time since by Judge McKennan at Philadelphia, on the ground that the issues involved were much the same as those in controversy in the New York suit of the same complainants against the People's Telephone Company The decision in that case having been given in favor of the patents, it seemed reasonably certain that a like result would follow in the case of the Overland company, and such in fact has been the result, although additional testimony was put in by the defense, tending to show that a pair of magneto telephones substantially similar to the apparatus subsequently patented by Bell had been constructed and used by Alfred G. Holcomb in New York city as early as 1863. A synopsis of the testimony of this claimant for the honor of the invention of the speaking telephone is given in another column. It is said that still another competitive telephone company either has been, or is about to be formed, based on the electro-phonetic telegraph patent of Royal E. House, well known as the inventor of the House printing telegraph. This invention was patented in 1868, and the patent is, therefore, near the expiration of its term. It is said to have recently been discovered that the apparatus covered by House's patent is capable of being used as a speaking telephone, although it is difficult to see how this, even if true, could enable the owners of the invention to maintain a successful defense against the Bell patents, for the reason that these have been construed by the courts to cover the method of operation as well as the apparatus. It is doubtful, however, if the promoters of most of these enterprises have any expectation of being able to maintain their claims before a court. Their principal object is rather to sell stock to a confiding public, but we should suppose that even this would have become a somewhat difficult matter by this time.

AN ELECTRIC LIGHT CONVENTION.

A convention of representatives of the electric lighting interests of the country is announced, to be held at the Grand Pacific Hotel, Chicago, February 25th. We fear that the importance of such a gathering has not been generally appreciated by those who should be most deeply interested in it. There is no branch of electrical industry so urgently in need of a periodical interchange of the views and experience of its workers, as that of lighting and transmission of power. Proper steps should be taken toward forming a permanent, and representative organization.

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THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 5.)

INSULATORS AND INSULATION.

In the construction of electric lines, it is utterly impossible to bestow too much care upon the insulation of the conducting wires. To my mind, one of the most wonderful and valuable discoveries in electrical science, was that of Stephen Gray; viz.: the fact, that while some substances will readily conduct electricity, others oppose in a marked degree such conduction. It is I think this discovery more than all others that rendered electric telegraphy possible. Such substances as conduct easily, we call "*conductors*."

Substances which offer a high resistance to the passage of electricity, are called " non-conductors " or " insulators." It is absolutely impossible to insulate wires too well, when they are to be used in telegraphy. Defective insulation is a sufficient cause to mar completely the efficiency of an otherwise well built line, fitted with the most perfect instruments, and supplied with abundance of battery or machine power. No substance known is absolutely a non-conductor, and it is therefore quite impossible to provide an absolutely perfect insulation; the best we can do therefore is to limit the escape of the electricity, and prevent it from exceeding certain bounds. Constructors of electric lines are doubtless well acquainted with the reasons for interposing insulating substances between the line wire and its points of support, yet a careful observation of many lines which come under our notice, indicates too surely, that if the constructors of such lines know, they at least " don't care "; since some of the insulators employed, and some of the methods of employing them, exhibit a lofty contempt for the laws of electric conduction, and an apparently deep-rooted idea, that the sole reason for the use of insulators real or alleged, is that we may have something hard and round, with a groove in it, for the wire to be fastened to.

In the choice of a suitable insulator several points demand our consideration.

First: the material of the insulator. Second: the form of the insulator. Third: the attaching appliances, and the method of attachment.

As to the material—glass, hard rubber, and porcelain or earthenware, are now, in some form, almost exclusively used, and kiln-dried or otherwise prepared wood is employed to some extent.

To obtain a material for an insulator, which is *in every respect* the best, is almost as difficult as to obtain a voltaic cell which combines all the conditions of perfection. The desideratum, is to obtain a material which as nearly as possible offers an infinite resistance to the passage of electricity; which does not readily conduct heat; which is non-porous, and has a surface which is and will remain smooth and free from cracks. It should not deteriorate when exposed to the weather, and should be a non-absorbent of moisture. No material has as yet been found which is free from all objection. There is also one more qualification which enters in a very marked manner in the choice of material in America—that is " cost "—it must be cheap—or it will not be considered.

Glass demands the first place, since in America it is almost universally employed. It meets many of the above conditions—being of high resistance—non-porous, non-absorbent, and readily obtainable of smooth and permanent surface. On the other hand it is a fair conductor of heat, and condenses the moisture upon its surface very readily, and is moreover very brittle and thus particularly defenceless with reference to the attacks of the small boy. In the climate of England, the surface of a glass insulator is almost always covered with a film of moisture to a greater or less degree, and therefore glass is not in that country preferred. In the United States where the climate is drier, this trouble has not proved sufficiently grave, to counterbalance its many advantages, and glass is accordingly used, more than any other material.

When insulators are well made of the best glass, and are rightly shaped, they give in a reasonably dry climate very good results, and if proper methods of testing were invariably adopted, and all insulators found faulty thrown out, the average of insulation would be greatly improved.

Hard rubber is used to a considerable extent in city and short line work, and is in the form of the well-known rubber hook, well adapted for covered wire or bare wire not over No. 12 B. W. G. also for soft copper loops. It has many good features: high resistance, strength and convenience. Its defects for this purpose, are its comparatively high cost, and also the rapid deterioration of its surface, which, when exposed to the weather soon becomes rough, and spongy, after that it has a tendency to gather and accumulate dirt and moisture, and its insulating properties are a thing of the past.

Porcelain is the material chiefly employed at the present time in England and European countries. It is a good insulator, is easily moulded into the desired shape, has a good smooth surface, and properly manufactured gives satisfaction. Unless however the manufacturer can be depended on, the porcelain insulator is treacherous, holding out, if defective in mass only until the external glaze cracks. When it is good, it is very good—and will no doubt continue to be used extensively in England. It is not a cheap material and this together with the fact that glass is found to answer, have kept it from general use in America.

Earthenware has been much used but its employment is diminishing in extent—its chief advantage is cheapness. The form of the insulator is of equal importance with the material. Why? Because though an insulator when compared with the material of the line conductor, it is none the less a conductor, when considered specifically; and as a conductor it is amenable to the law of conductors; that is, the less the diameter and the greater the length of the surface, the greater is the resistance exposed to the escape of the current. This teaches that we should make the insulator of such a form, as to bring a considerable length of surface between the point where the wire is supported, and the point at which the insulator itself is affixed to the pin or bracket; while it should also be made so as to expose very little width of surface between the same points. Another point also requires some attention: in making insulators which meet the above requirements, the necessary quality of strength must not be overlooked.

The insulator shown in figure 3 below, is now much used in England and is well adapted for insulating purposes, on account of the great length of the surface between the wire and the pin.

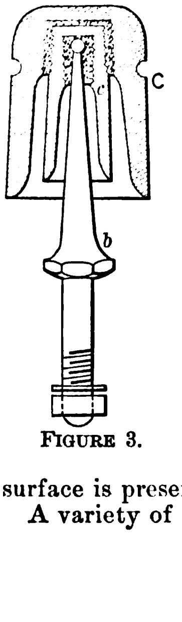

FIGURE 3.

It consists of two cups, one inside the other; the inner cup *c* is fixed to the outer cup C, by cement, and the bolt *b*, is cemented into the inner cup.

The glass insulator used in the United States is by no means so perfect as regards form. It is shown in the figure below; and has but one cup, furnished with a skirt which overhangs the surface of the pin. The length of surface is much less than the English form, and escape is proportionately easy. Could we obtain the glass insulator provided with the concentric cup, insulation would be improved.

An attempt has recently been made to improve the American insulator in this respect, by slitting the thread which screws on the pin vertically, so that less surface is presented to the pin.

A variety of porcelain knob has been used to some ex-

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tent of late years as a pole insulator. It consists merely of a short porcelain knob of cylindrical form, and having a countersunk wood screw hole extending through it. It is fastened on with a single screw which passes through this hole. It is hardly worth calling an insulator, although some telephonic constructors of sanguine and imaginative temperament have used it in that capacity. Neither size nor shape is adapted for such a purpose. The knob was made to serve as an attachment, for use especially in protected places to which covered wires might be fastened. As an attachment it is all right. As an insulator it is worthless.

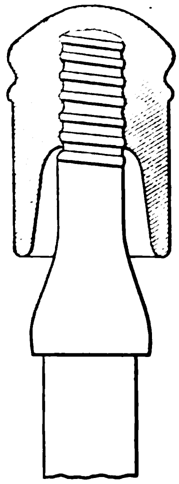

FIGURE 4.

ATTACHING APPLIANCES.

The English porcelain insulator has until quite recently been cemented, in the way shown in figure 3, to the head of an iron pin, the pin being furnished with a heavy bolt at its lower end, this being adapted to pass through the cross arm, and to be held by a nut on the lower side. Cements in insulators are always bad, and this arrangement has not been satisfactory. Recently an improvement has been introduced, substantially the same in effect with the screw attachment which we in America have so long utilized.

The way it is applied to the English insulator is clearly shown in figure 5.

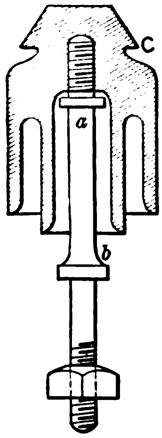

FIGURE 5.

The ordinary method of attaching the insulators in this country is indicated by figure 4, and is simply to mould a thread in the hollow or cup of the insulator, to cut a corresponding thread on the pin which is of wood, and to screw the insulator into place on the pin. A remarkable patent was taken out last spring for what was entitled "Means for Insulating and Supporting Electrical Wires." The alleged insulator comprises a block of wood, notched like a clothes pin to some depth, and having in some instances a flat surface for nailing to poles, and in others, a wedge-shaped end to drive in holes bored in cross arms. The block may be nailed through its solid part to the pole; a sheet of pliable india-rubber or some such material is doubled and placed in the slit, and the line wire is slipped up between the two surfaces of the rubber. The free or open ends of the slitted block, are then to be nailed together and to the pole, clamping the wire. This is said to give excellent insulation and to be very cheap.

We are reminded of an anecdote of the late French General Bosquet; who, it is said, after watching the British Light Brigade, 600 strong, charge the entire Russian army at the Crimea, remarked "This is magnificent, but it is not war." So with respect to this device we are constrained to say: "It may be neat, it may be cheap, it may be durable, but it is not an insulator." The American constructor will do well to stick to glass and bracket for a while longer.

Insulators should be attached where they can be well washed with every heavy rain. They should never be attached horizontally or below a cross arm because in that case the water from rain flows in, and makes a first-class conducting surface to the pole. Hook insulators especially should never be placed with the petticoat upwards. A short line does not need the extreme care in the choice of, and attachment of insulators that is essential to the good working of a long one. A single telephone line will often work clearer during the transmission of conversation when it is slightly leaky, provided the leakage is uniform; and it is indeed surprising to note, how little the telephone depends upon insulation.

As we cannot however maintain a uniform leakage—and as moreover we need a well insulated line to send call signals over, it is found more satisfactory on the whole to insulate the line well; especially when more lines than one are extended on the same poles, because in that case the leaking currents pass into other wires disturbing and confusing the passing messages. A great deal of the alleged induction between telephone wires, is without doubt due to direct leakage between wire and wire.

The excellence of the insulation of a line depends upon several conditions: The material and form of insulator, the number of supports per mile, and the size of the conducting wire, all have their share in determining this function.

According to Culley, insulation should never fall below 200,000 ohms per mile in wet weather.

(*To be continued.*)

STATISTICS OF ELECTRICAL PATENTS ISSUED FROM THE U. S. PATENT OFFICE IN 1884.

BY T. D. LOCKWOOD.

THE following statistics relative to the issue of electrical patents during the year 1884 have at least one merit. They are early—and, I think, correct. As everyone knows who has tried to classify electrical patents, the work is not easy. A patent for a cable, for example, may include a device for preventing induction—in such cases I have regarded the patent as being for the invention claimed.

The total number of patents issued for electrical inventions during 1884 is 1,166. Total number of patents issued in 1884 is 18,799.

SUBJECTS OF INVENTION.

Telegraphs.	
Autographic Telegraphs	3
Automatic "	7
Fire Alarm and District Telegraphs	30
Telegraph Instruments, Keys, Relays, Repeaters, etc.	17
Multiple Telegraphs, Duplex, Quadruplex, etc.	19
Printing Telegraphs	32
Telegraphy—New Systems	13
Alarms.	
Annunciators—Indicators and Alarms	42
Burglar Alarms, and Watch Clocks	10
Railroad Signals	46
Electric Lighting.	
Arc Lamps	82
Incandescing Lamps	40
Electric Lamp Fixtures and Fittings	2[illegible]
Electric Lighting Apparatus, Switches, Cut-outs, etc.	30
Sources of Electricity, Primary or otherwise.	
Primary Voltaic Batteries	31
Dynamos and parts thereof	75
Regulators for Dynamo Electric Machines	22
Secondary Batteries	36
Conductors.	
Cables, Compound Conductors and manufacture of the same	41
Insulated Wires, etc.	17
Insulating Materials.	
Line Wire, Compound Wires, etc.	13
Underground Systems	51
Construction.	
Couplings, Binding Screws, Joints	11
Inside Construction	1
Insulators for Pole Lines	18
Supports and Poles	14
Special Systems of Utilization.	
Clocks, Time Regulators and Distributors	30
Electric Distribution and Meters	23
Remedies against induction, etc	11
Electric Gas Lighting	12
Lightning Arresters, and Protectors against abnormal currents	19
Transmission of Power, Motors and Railroads	45

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Electro-magnets	6
Galvanometers and Measurement	5
Switch-boards and apparatus therefor	13
Telephones, and Telephonic Appliances.	
Transmitters	51
Receivers or Reproducers	26
Telephone Apparatus including automatic switches, etc, but excluding signals	40
Telephone Exchange Systems, and circuit arrangements	18
Individual Signals	6
Telephonic Repeaters or Relays	2
Telephone Signaling Appliances	22
Mechanical Telephones	14
Miscellaneous Applications	89

It is thus seen that telephonic invention still heads the list with 179 patents, electric lighting closely following with 177.

Considering the inventors from an alphabetically arranged list it is found that the number of patents assignable to each letter of the alphabet is as follows:

Inventors having the initial A — 21; B — 107; C — 57; D — 49; E — 39; F — 47; G — 60; H — 93; I — 1; J — 24; K — 32; L — 45; M — 58; N — 10; O — 10; P — 63; Q — 0; R — 44; S — 150; T — 60; U — 1; V — 60; W — 133; X — 0; Y — 1; Z — 1—total, 1,166.

The banner letter is thus found still to be S, presumably owing to the legendary impatience of our common ancestor Adam, who, it is said, after naming the greater part of his descendants became very tired, and gave utterance to the immortal dictum, "Let all the rest be named Smith."

The letter W takes the second place with 133, owing to the inventive efforts of Messrs. Weston and Waring; while B is third with 107. The letters Q X alone are unrepresented.

I, U, Y and Z, have 1 each.

In 1884, there were 53 weekly issues of patents. The average weekly issue is exactly 22 electrical patents.

THE OVERLAND TELEPHONE CASES.

On the 13th of January, 1885, Judge Butler, in the United States Circuit Court, granted to the American Bell Telephone Co. a preliminary injunction restraining the Penn Overland Co., of Pennsylvania, from using a transmitter and receiver in telephones claimed to be an infringement of the Bell patent. This motion was originally made a year ago, but owing to the fact that a similar question was involved in the People's Telephone suit then pending in New York no decision was given. Recently, however, the New York case was decided in favor of the Bell patent, and the motion for the preliminary injunction was again called up before Judges Nixon and Butler several days ago. A re-argument was had upon the ground of the introduction of new matter, but counsel were limited to a day's hearing. Judge Nixon heard the case, together with Judge Butler, because of a case existing in the New Jersey courts, and which was argued for the sake of convenience, in connection with the Pennsylvania case.

Judge Butler delivered his opinion orally, and said:

In the case argued a few days ago, involving the Bell Telephone patent, the Court is prepared to dispose of the motion for a preliminary injunction, but does not esteem it necessary to file a written opinion. When the motion was called up for argument last spring the case was fully heard and counsel were listened to at great length for some three days. Upon consideration of the evidence before us and the arguments of counsel, the Court was of the judgment that everything of essential importance was embraced in the case between this same plaintiff and the several defendants with whom he contested the validity of his patent, except the claim here set up that Drawbaugh had anticipated Bell. Inasmuch as that question was involved in a case then pending in the Circuit Court of New York, which was ready or nearly ready for final hearing, the Court esteemed it unwise to dispose of that important question of fact upon ex-parte affidavits before us. The motion was laid over, therefore, to afford the parties an opportunity of having this question (the claim on behalf of Drawbaugh) settled, in that case, where, from the character of the proof, it could be done with much greater prospect of doing justice to the parties. Had it not been for the introduction of this question into the case, the Court would have granted this motion at that time.

It was not for the Court to say whether the conclusions reached in the former cases alluded to were sound, or otherwise. Proper regard for the courtesy due from one circuit to another, as well as for the importance of harmony in the decisions of the respective circuits, required that he should treat these decisions as conclusive until reversed by the court of last resort.

Upon the case in the Circuit Court of New York being disposed of, this motion was again called up. Counsel for respondents asked to be heard on the ground that new matter had been introduced since the former argument. The Court esteemed this a reasonable request, and counsel were heard. Upon full consideration of the alleged new matter and the arguments of counsel, urged with great zeal and great ability on behalf of respondent, it is the judgment of the Court that part of the new matter was involved in the former cases, and that to the extent that it was not so involved all of it of material significance was within the convenient reach, and, it is safe to believe, within the knowledge of some, if not all, the numerous counsel employed in these cases, and it was not introduced and pressed simply because it was esteemed less available—of less importance for the purposes of defense than the matters which were introduced, pressed and passed upon.

Upon full and patient examination of everything submitted to us, we believe that the alleged new matter is but the refuse and dregs of the former cases; if I might be allowed the use of so homely an illustration, I would say, but the heel taps found in the glasses at the end of the frolic.

The motion is therefore allowed.

Judge Nixon disposed of his case at Trenton by granting a similar motion for an injunction.

The new matter introduced by the defendants consisted of a number of depositions relating to an alleged prior invention of the speaking telephone by Alfred G. Holcomb, a well-known wood engraver of New York city, and a man of considerable scientific acquirements. The deposition of Mr. Holcomb contains a story but little less incredible than that of Drawbaugh. He deposed that he made experiments in New York in 1859 with a view of shortening the alphabetical telegraphic code by the use of different tones. Having made several experiments with a stretched wire and a tuning-fork, which were thrown into vibration by an electro-magnet, he says he was led to make use of a combined permanent and electro-magnet having a steel bow armature attached to the centre of a wooden sounding board. He afterwards constructed a duplicate of this instrument and attached to both of them tin speaking-tubes with porcelain mouthpieces. He claims that in the fall of 1860 he experimented with the late Dr. Leverett Bradley, and that they first tried to get the sounds of the phonetic alphabet, but that in putting these sounds together they reproduced words. He says he afterwards made other experiments with other parties, and also with his wife and other persons in New York, Cape Island, New Jersey and Cecil County, Maryland, and that he transmitted articulate speech. This, he says, was prior to the summer of 1863. He did nothing with the instrument from that time until the summer of 1877, some time after the experiments of Bell were published. He says that although diligent in trying to obtain the assistance of capitalists he was unable to do so, otherwise he would have filed an application for a patent at that date. Mr. Holcomb however failed to produce any witnesses in support of his claims who were willing to testify that they heard articulate speech, with the exception of his former wife, whose evidence in this respect was confirmatory of his own. The story is a somewhat remarkable one, for although there seems to be very little doubt from the evidence produced that Holcomb constructed in 1860 an instrument essentially the same as the Bell telephone, and which might have been capable of use for the transmission of articulate speech, it is extremely improbable that he ever made, or even contemplated, such a use of it.

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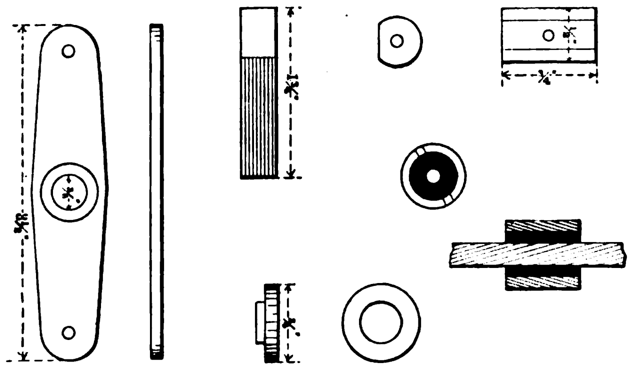
ELECTRICAL MOTORS AND THEIR CONSTRUCTION.[1]

BY JOHN E. CHASTER.

(Continued from page 6.)

THE commutator is the next portion of the motor requiring attention, and is fitted to the shaft, as shown in figure 17, partly in section, also in figure 18, by an end view. The broad, black portion represents the insulating material, such as vulcanite or hard wood, which must be bored and turned so as to fit tightly to the spindle, inside the longest bearing of the machine, as shown in figure 10. Secure it well by means of a pin driven through, or a small set screw. Next procure a piece of brass tubing that will

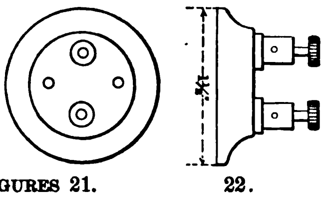
FIGURES 14. 15. 16.



FIGURES 12. 13. 19. 20. 18. 17

fit tightly over the vulcanite or wood ; this should be secured by small brass screws on the edge of the tubing, diametrically opposite. At right angles to the line of screws, with a fine saw cut the tube longitudinally, as shown in end view, figure 18. When the two segments of the commutator are removed, see that the pin or set-screw, which holds the vulcanite to the spindle, does not project so far as to touch the brasses of the commutator, when the latter is screwed home. Neither must the screws that hold the commutator be long enough to make metallic connection with the spindle. Directions will be given hereafter for making tests for faulty contacts of this nature. Figure 12 is a front, and figure 13 a side view of the holder of the commutator brushes. This fits on outside the boss of the bearing having a thread, and is held by a set-screw (see figures 19 and 20). Two small pieces of vulcanite, shaped as shown in figures 15 and 16, are screwed to either end of the commutator holder.

The commutator brushes (figure 14) are best made by cutting hard drawn copper wire into equal lengths, carefully straightening the same, and soldering them to a brass carrier. The latter has a slot cut through, so that the distance can be regulated, in order that the wearing of the commutator may be allowed for. Figures 21 and 22 are



FIGURES 21. 22.

the top and side views of a piece of polished vulcanite, with two binding screws fastened firmly to it. The ends of the binding screws must not go through to the bottom, for the reason that when the piece is screwed down to the top of the field magnets it should not make an electrical connection with the latter.

(*To be continued.*)

1. *English Mechanic* (abridged).

UNDERGROUND TELEGRAPHY.

THE following report upon the employment of underground lines and cables for general telegraphic purposes, which has recently been made to J. W. Mackay, President of the Postal Telegraph and Cable Co., by Sir William Thomson and Fleeming Jenkin, will be found of much scientific as well as general interest.

No. 18 FITZROY STREET, LONDON, W.

J. W. MACKAY, Esq.:

Dear Sir—In the report which we now have the honor to submit on the employment of underground wires for telegraphic communication we have made no attempt to treat the subject exhaustively. We believe that your object was to obtain our opinion on two broad questions—whether a telegraphic system could be worked rapidly and efficiently through underground lines, and whether these lines would be durable. Messrs. Siemens recommend an underground cable similar to that which is used by the German government. This cable contains 7 copper strands, each weighing 90 pounds per mile, and insulated with gutta percha weighing 76 pounds per mile. The 7 insulated wires are contained in a sheath of 24 galvanized iron wires, each 0.102 inch diameter. The weight of the iron is about 4080 pounds per mile. These iron wires are further protected by jute and compound. The weight of the whole cable is about 6100 pounds per mile. Its breaking strength is 4½ tons. This type of cable is well suited for the purpose to which it is applied.

Experience has shown that cables of this description buried in the ground without further protection are extremely durable, and are exposed to very few accidental injuries. We are unable to fix a term to the life of these cables, because up to the present time no similar cable has, we believe, required renewal or shown any sign of serious injury. These remarks apply both to the iron sheathing and the gutta percha core. No insects have, as far as we know, attacked the gutta-percha in these or similar cables, either in this country or in any other. The experience in temperate climates has been large, and some very considerable lengths have been employed by the German government to form a network of lines for military purposes. In hot countries some experience has been derived from short lengths of cable used in trenches on land to connect submarine lines with land stations. In some cases extreme heat has injured these short connecting lines, but we believe that this has occurred only where proper trenches could not be dug for their protection. We are, therefore, of opinion that, as regards durability and freedom from accidental interruption, underground cables would give very satisfactory results.

The transmission of messages through underground wires is subject to two actions which tend to limit the number of signals which can pass from station to station in a given time. The name induction is commonly applied to both these actions, which may be distinguished one from the other as static induction between the copper conductors and the earth, and magnetic induction between adjacent insulated wires. We believe that in all cases likely to arise in practice, magnetic induction may be neglected, and, moreover, its effects can in some degree be neutralized by judicious arrangements. The effects of static induction cannot be estimated by any known contrivance. The well-known limitation of speed through submarine cables is due to static induction, and a similar action takes place in all underground wires. Formulæ derived from submarine lines enable us to calculate with considerable accuracy what traffic can be passed through long underground lines of a given type when these are worked with the same expensive instruments as are employed for the submarine lines. Thus, with the type of cable described above, we reckon that by using the siphon recorder, or mirror instruments, a good clerk would work at his full speed sending from 20 to 30 words per minute through any length not exceeding 1000 miles. A high class of clerks would, however, require to be employed, and it is possible that magnetic induction from wire to wire would in these great lengths be inconvenient. We do not believe that transmission by underground lines in this manner would be likely to compete on favorable terms with transmission by overhead wires. It has therefore been our duty to satisfy ourselves as to the traffic which could be carried on by ordinary apparatus through the underground lines. The officials of the English post-office informed us that they were without any knowledge on the subject, but Mr. Preece, the engineer-in-chief, was, however, so obliging as to offer us for experiment the use of some new underground wires now being laid near London, and we made a series of experiments, with the following results, using a good Morse recorder and a Wheatstone automatic sender:

Length of Line. *Miles.*	*Words per Minute.*
27	more than 220
88	130
116	100
181	35

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On the length of 181 miles a similar experiment was tried with hand sending and a Morse sounder, as the receiving instrument worked by a relay; 30 words per minute were sent, and probably the full speed of 35 words could have been reached by a good clerk. The general conclusion is that for short lengths, such as 30 miles, extremely rapid sending by automatic instruments might be employed, and duplexing, or even quadruplexing, might be employed. On lines of 100 miles automatic instruments could still be employed with advantage, but the effects of static induction would be quite sensible and would render any speed greater than 130 words per minute difficult of attainment. The ordinary hand signaling could be practiced with no sensible impediment on all lines under 200 miles in length, and at this distance relays could be worked retransmitting the messages automatically, so as to connect places distant from each other by at least 500 miles. There is no doubt whatever that any amount of traffic could be worked through a system of underground wires at the usual rates of hand sending.

The expense of establishing underground cables must always be greatly in excess of the cost of aerial lines capable of transmitting the same amount of traffic. But in cost of maintenance we believe that an underground system would compare very favorably with aerial lines. Underground wires will also be almost wholly free from interruptions due to storms or to extremes of heat and cold, whereas aerial lines, however well constructed, must always be subject to injury from wind, snow and extreme cold.

We have heard it suggested that lines composed partly of underground wires and partly of suspended wires would be more difficult to work than lines constructed wholly on the one or the other system. This is an error. It is, however, perfectly in accordance with the theory that the addition of any considerable length of aerial wire to a long underground circuit will materially reduce the speed of working. The reduction in the speed will, however, be less than if the length of line added were also composed of underground wires. Thus, in the experiments already spoken of, an addition of 50 miles of aerial line to the 181 miles of underground line reduced the speed from 35 to 28 words per minute. But if an additional length of 50 miles of underground wire had been added the speed would have fallen to 15 words.

Yours very sincerely, THOMSON & JENKIN.

THE ECONOMICS OF INCANDESCENCE LAMPS.

In a recent communication to the London *Electrical Review*, Alexander P. Trotter says:

Dr. Fleming pointed out to me, some years ago, that the value of an incandescent lamp is the product of its candle-power into its life divided by the product of its number of watts into its price. The cost per hour for power and lamp renewals is therefore

$$n\,e\,c + \frac{p}{l}$$

where e is the number of watts per candle-power, n the cost of a watt-hour, c the candle-power, p the price of the lamp, and l the life of the lamp in hours.

It is evident that the relation between the important variables, e and l, depend on the external circumstances, n and p.

We may take as extremes, ½d. and 1½d. for the cost of an electrical h. p. of 746 watts, and for the prices of lamps, 2s. 6d. to 7s. 6d. With a 20 c. p. lamp, taking 4 watts to the candle, the cost of power per hour, at ½d. per h. p., is 0.0535d.; and at a price of 2s. 6d., and a life of 1,000 hours, the renewal cost per hour is 0.03d., making a total of 0.0835. But if, other things being the same, the efficiency is raised to 2½ watts per candle, the cost of power becomes 0.0335 and this, subtracted from the total, leaves 0.05d. for lamp renewal; this is equivalent to a life of 600 hours. An exactly similar result is obtained with power at the high rate of 1½d., with a lamp at 7s. 6d.

But with power at the high rate, and with a lamp at 2s. 6d., the life comes to 333 hours; that is if a lamp with 4 watts to the candle has a life of 1,000 hours, and an increase of efficiency from 4 to 2½ watts (or 60 per cent.) be obtained, the life may be decreased from 1,000 to 333 (or 66.6 per cent.), without altering the total cost of the system. And it follows, that if the lamp still has a life of 1,000 hours, it is worth as much as 3 of the lamps of lower efficiency.

In short, if the lamp is very expensive, say 7s. 6d., and power may be had for a mere nothing, all our attention must be devoted to prolonging the life, the efficiency being nugatory; but if we could get lamps at a fair and reasonable price, say 9d., and were forced to use some extravagantly expensive source of power, such as a primary battery, we should strive to attain a high efficiency, the life being only a question of the trouble of replacing the dead lamps.

There is, however, an aspect of the question which is, in general, more interesting than the mere structural differences of the lamps, and it applies to the whole system of incandescence lighting. The efficiency of any given lamp varies as some function of the degree of incandescence or actual candle-power; the life also varies inversely as some function of the same, and it is possible that these two functions are identical. Be that as it may, the important question then arises—at what degree of incandescence (determined preferably by the spectrum) should the lamp be run in order that $n\,e\,c + \frac{p}{l}$ may be a minimum?

It is most unfortunate that we are still practically without any authentic information on these points. It is true that it is a simple matter of measurement to determine the former, but then it is only good for one class of lamp, while time only will determine the life; moreover, where is there a lamp running day after day under the same potential and under regular conditions of work?

It appears, then, that under average conditions, if we can get a lamp taking 2 watts per candle, we ought to be satisfied (relatively) with a life of 600 to 700 hours; and when the time comes and it should have come by this time, for a shilling lamp, a long life would be a question of convenience rather than economy.

With the present high prices, the value of lamps of high candle-power is most important, and appears to be strangely neglected.

A noticeable feature in the more efficient kinds of lamps is their color; the filament is lost in a blaze of white light which puts to shame the "4 watt red-hot hairpins."

CRIBBING.

The December number of the ELECTRICIAN AND ELECTRICAL ENGINEER cribs entire, except the headings, an editorial article which appeared in the September 20th issue of the *American Machinist*, entitled, "A Bogus Electric Light Company." The article related the method employed by a New York electrical expert to prick an electric lighting bubble, and save the money of a client who had been solicited to invest in the scheme. Our electrical contemporary substitutes for ours the heading, "Saved His Money," to which variation we should probably make no objection were the article itself not credited to another journal, which is said to "vouch for" the truth of the story. As we omitted to state the name of the expert in question, neither the voucher nor the vouchee, however, seems able to tell who he is. Next time we shall endeavor to be more considerate.—*American Machinist*.

We copied the article from "another journal" in which it appeared as original, and gave what we supposed to be proper credit for it in accordance with our invariable custom. How should we know that it originally appeared in a paper which we had never seen? Our esteemed mechanical contemporary appears to have a peculiar code of ethics. He finds stolen property, from which his mark has been removed, in the hands of an innocent third party. He has not a word to say against the original kleptomaniac, but is filled with unspeakable indignation at the conduct of the holder of the goods. Neighbor, that is not even law, much less common sense!

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EVOLUTION OF THE ELECTRIC RAILWAY:[1]

ITS COMMERCIAL AND SCIENTIFIC ASPECT.

BY DR. WELLINGTON ADAMS.

(Continued from page 15.)

WE must consider something besides the mere propulsion of a car. Electricity possesses innumerable novel and superior qualities or features which have never heretofore been presented to the railway constructor, although fully appreciated by railway economists. It behooves us to grasp and make the most of these. To be sure, some kind of operation may be for a while attained at maximum outlay, in a primitive, impractical manner, but that which should be striven for is maximum economy as regards mechanical return, and such perfection in operation as will insure a minimum wear and tear. The application of electricity to railway propulsion means a complete revolution in railway construction and manipulation. In dealing with electricity as an agent of locomotion, it is unnecessary that we should adhere to those methods and processes which experience has demonstrated as essential to steam locomotion. On the contrary, having a totally different element to deal with, new problems are presented and new principles involved. In handling the question of steam locomotion, Stephenson, after giving preference to the principle of traction over cables, concluded that it would be decidedly best to apply the power directly to each axle, or, better still, to each wheel of every car, and operate each car separately. Finding such an arrangement impossible, however, he next decided upon making each car at least its own locomotive. But this system also proving impracticable with steam, he, as a *dernier ressort*, adopted the "train system," with its ponderous locomotive. Had Stephenson and his followers found it as practicable with steam as we now find it with electricity to apply the power direct to each wheel, the long "train system" of locomotion would never have been instituted. One of the first requirements, therefore, of an electric railway system embodying the elements of permanency and commercial success is the abolishment of the locomotive and its essential dead weight, which in turn does away with the "train system" and its numerous objectionable features. When a number of cars are coupled together their wear and tear and weight are necessarily greater. The impetus of a train being thus increased, it becomes more difficult to stop it, and the results of an accident are more disastrous both to life and property. The amount of air always carried between the cars of a train offers great resistance. All curves must be of higher degree than would otherwise be necessary, and a very much larger percentage of power is lost in making the curves than would be the case in a system applying the power to each wheel or axle. In the train system, if one car catches fire or jumps the track, others are very likely to do the same, and thus again is the company's yearly expense greatly increased. The cars being individually heavier, and the necessity of providing for the weight of the aggregate number of cars massed together in the train system, increases the cost of the road-bed and all culverts and bridges. When we dispense with the locomotive and its attendant dead weight, we abolish the cost of the power consumed in propelling the same, and we greatly lessen the principal cause of wear and tear of the road-bed, culverts, bridges, etc., and, furthermore, we render possible the use of much lighter rails, and thus again further reduce both the first cost of construction, or the capital invested, and the cost of operation. Cars which are not being continually bumped together and wrenched to pieces by a heavy train may certainly be built lighter. In the locomotive train system the weight which must be provided to supply a proper amount of adhesion between the rails and the wheels is a *dead* weight, requiring as much power for its propulsion as is required by the remainder of the train; in fact, 19 tons of dead weight must be hauled for every ton of passengers carried. Furthermore, this necessary dead weight is a fixed quantity, and does not vary with the actual paying load to be hauled. The adhesive power and its attendant dead weight to be propelled remain the same whether the accompanying cars are but one-tenth filled or fully loaded, and railway statistics show that the average number of passengers carried by each train is but 70; whereas in a system having the tractive power distributed, whether the cars be run singly or in trains, the weight which gives the adhesive power is more nearly proportionate to the load to be carried; and the weight which contributes this adhesive power is not a dead weight, but one that the operators of the road receive pay for. As each passenger enters a car, an additional weight is supplied for the exertion of just as much extra traction between the rails and the wheels as is required to propel such an increase in the load.

Here, then, we have an expenditure directly proportionate to the demand, the height of economy being thus attained. A no less important indication in railway propulsion looks to the application of the power *directly* to the point where it is to expend itself. Be this never so desirable, however, such a thing is impossible with steam, but in every way practicable with electricity—indeed, electricity seems here to have found its grandest and most important application. Again, an all-important indication for a successful electric railway may be said to lie in the fact that an electro-dynamic machine, when operating with greatest economy and safety, must, like a generator, run at a predetermined maximum speed. Hence, provision must be made for varying the speed of the car by some other means than by varying speed of the electric motor. Means must be provided for allowing the armature, or that portion of the electric motor which revolves at a high speed, to attain full headway independently before any load is placed upon it, and the latter should be applied gradually, in order to avoid jerks. In addition to the economy and safety insured by this arrangement, we, in starting, allow advantage to be taken of the impetus of the motor in overcoming the inertia of a car; and, furthermore, we do not compel the motor to do its work rapidly, since it is a *sine quâ non* of an electric motor that it shall do its work slowly. Thus will it be possible for an electric car to attain maximum speed almost at the start, whereas from an eighth to a half mile is required for a steam engine to acquire its running speed. This one point alone renders electricity, when properly applied, particularly suitable for city surface and elevated roads, where frequent stops are necessary.

It must also be possible to vary the quantity of electricity running through the car, or, rather, of varying the quantity tapped from the main supply, without introducing useless resistance. There must, furthermore, exist at the central or generating station an automatic regulator, or equivalent arrangement, which will keep the supply of electricity in the mains always proportionate to the demand, and which shall regulate the amount of fuel consumed in the steam engine so that it likewise will be proportionate to the power or electric energy absorbed throughout the system.

But little, if anything, has been done toward developing the electric railway outside of what Dr. Siemens did in 1879, namely—the simple mounting of an electro-motor upon a car and connecting this up by means of a leather or chain belt, or by a train of cogs, with the car axle. Siemens at first built an electric locomotive, but we notice he soon abandoned this principle and began mounting his machines on each car and connecting these up with the axles by means of belts. Evidently, his discerning mind soon grasped the situation, and he began applying the power in a way better calculated to develop the superior advantages of electricity.

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1 Read by the author before the Engineer's Club, of St. Louis, April 23, 1885, and published in the *Journal of the Association of Engineering Societies.*

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Edison and Field, however, have adhered to the locomotive principle and train system, as witness their exhibitions at Chicago and Louisville.

It certainly requires but little mechanical knowledge to appreciate the weak points about all these.

In the first place, either the cars must be mounted upon their axles rigidly without springs, or else the motor, which is mounted upon the car, and the axles with which the motor is geared will move differently and will not always be in line.

Second, no form of belting will do for a practical commercial railroad—that is simply out of the question, as every engineer must concede at once.

Third, gearing between parts which move differently and are constantly getting out of line is also impractical.

But little has been done toward thorough insulation for the conductors and in devising a practical moving contact.

Absolutely nothing has been suggested as a means of economic regulation, in every instance useless resistance being used, and the current wasted in useless heat.

To recapitulate:—Among the many advantages of electricity properly applied as a motor over steam for passenger transport is the circumstance that no heavy machinery or fuel has to be carried about to set the train in motion. The carriages, running singly, may be built much lighter, thus reducing the power necessary to move them; reducing the noises made in running, greatly lessening the wear and tear of both tramway and rolling stock; reducing the first cost of cars; reducing the force required to brake the cars when going at a high speed, the impetus being less; reducing the force of concussion in case of accident, and hence the dangers and destruction to life and property consequent thereon; and, finally, permitting all bridges and other superstructures to be built more cheaply, more artistically and less weighty than has heretofore been possible. Furthermore, for the same reason, and also because of the distribution of motive power attainable, greater speed may be acquired, sharper curves rounded with less than the usual wear, and steeper grades may be climbed. Experienced and trained engineers and firemen are not required to operate an electric railway. Any boy possessed of ordinary intelligence may be taught in half an hour to manage a car perfectly and cause it to perform all the work of a steam locomotive. This feature alone does away with a great source of expense now incurred by all steam railways, whether elevated or surface. The electric system also admits of the use of large, stationary, protected steam engines of the most economical type. The use of these, as against small, exposed, portable ones, reduces immeasureably the wear and tear, as well as first cost, and also the amount of fuel necessary to develop a given amount of power; and if water power be utilized—as would very frequently be possible—the cost of operating such a railway system can be reduced to a comparative minimum. Further advantages are: Ability to get up speed quickly, which is particularly desirable for street and elevated roads; absence of noise; freedom from liability to many forms of accident now unavoidable, and from the annoyance of flying sparks, cinders, smoke, gases, grease and the many other offensive and dangerous accompaniments of our steam railway system.

The time is now surely at hand for the economic and advantageous employment of electricity as a cleanly and cheap means of effecting rapid passenger transportation through densely populated cities and across the continent. Jacobi, Davenport, Davidson, Little, Pinkus and Page were in advance of the age in which they lived. No more rapid transit was demanded at that period of the world's history. The dynamo-electric machine, which we have seen has rendered feasible the electric railway, was not then in existence; hence they were obliged to apply electricity as a primary motor, an office which is filled far more economically by the steam engine, as was shown by their contemporaries in science—those versed in mathematics and thermo-dynamics. Now, however, the time is ripe for its introduction. We have reached the period of transition from the stage of practical demonstration to that of practical application. We now know how to apply electricity as a *secondary* motor; the dynamo-electric machine has been introduced as an industrial feature of our age; the project of electric railway transportation *now* has the sanction and enthusiastic support of the learned in the sciences of electricity, dynamics and mathematics; and, lastly, we live in an age which demands more rapid transit. We think fast and live fast, and this naturally begets an almost insatiable desire and necessity to travel fast. Railroad managers are expected to provide the means of gratifying this desire with safety to passengers and without detriment to their earnings, if possible; but at all hazards to put trains through according to the latest and fastest schedule. For a number of years the regular time between New York and Chicago has been 36 hours, or a speed of 25 miles an hour, including stops. This is not what might be called slow, but the impatient public is more than ever impressed with the idea that "time is money," and that something better than this should be accomplished, in view of the improvements in rails, road beds and rolling stock. Managers, in order to meet this demand, are put to a terrible strain. They must provide the ways and means, head off competition, take the responsibilities and risks of accidents, and, what is more important than all, they must make the traffic pay.

This last requisite, in the face of rival fluctuating rates, the enormous dead weight of locomotive and tender, of sleeping and drawing-room cars, and the excessive wear and tear of track, superstructure and rolling stock, from the increased weight necessary to effect such rapid transit *with the steam system*, is not an easy thing to respond to. Managers, master mechanics and car builders have for a long time regarded the rapidly increasing weight of trains as a growing evil that should be checked, to prevent expenses from swallowing up earnings in passenger traffic. Fast running under existing conditions is extremely hazardous, as well as expensive, and this simply because of the enormous weight given to railway trains. The tractive force of 20 to 60 tons exerted by the driving wheels of a locomotive on an eighth-of-an-inch of rail soon tears a tramway to pieces. These conditions are practically reversed in the writer's electric railway system. It might almost be said that here the lighter the rolling stock the greater the possibilities as to speed. Calculations based on the numerous points of advantage herein specified show that an electric railway may be operated at an average speed of 60 miles an hour for one-third the cost of operating by steam at the same speed.

If the train system must be discarded as least calculated to develop the advantageous qualities of electricity a[illegible] plied to railway propulsion, then a practical meth[illegible] applying this power upon each car must be devis[illegible] this has by many eminent engineers been found to [illegible] no easy matter, but, on the contrary, a most complex question, fraught with many difficulties. The armature of the electric motor must run at a high speed, and its power must be transmitted to the wheels of the car by a *positive* gearing. All forms of belting were at first sight seen to be entirely impracticable; while gear wheels between parts moving differently were not to be considered. Everything electrical and mechanical, including that fundamental law of mechanics which directs that power shall in every instance be applied as *directly* as possible, seemed to point toward a direct application to the wheels. But how was this to be accomplished? As we have before noted, the armature or revolving part of the electric motor must move at a very high speed, entirely too high for the speed of a car wheel. And, furthermore, it is very evident that it was impossible to construct an "armature" upon the modern dynamo principle which should also serve as a car wheel—such a dual function was out of the question. And

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yet it was imperative that the principle of the motor should be that of the most efficient type of the modern dynamo.

However carefully the reader may examine into our simple solution of this question, no adequate conception can be formed of the amount of thought and work which has been bestowed upon it.

We have succeeded in applying the power directly to every wheel, to the point of traction, where the power is absorbed, the work done; and yet our wheel is neither an " armature " nor a " field " of a dynamo. It is both combined! In other words, every wheel is a dynamo in itself. Each wheel is *animated*, having power within itself. Hence every wheel becomes a veritable locomotive. Let us for a moment look into the construction of this anomaly. It is composed of two parts, one constituting the " field " of the motor, and at the same time serving as the tire-supporting portion of the wheel; while the second part represents the " armature " of the motor, and revolves within, and in an opposite direction to, the first. Hence it will be observed that the wheel is formed of two separate and distinct parts, both of which revolve, but in opposite directions. Both parts have a continuous tendency to pull toward each other, the poles of the two electro-magnetic rings, or inductors, being always kept at a minimum distance apart. The two electro-magnetic rings mutually act upon each other inductively throughout their entire length. The inner ring

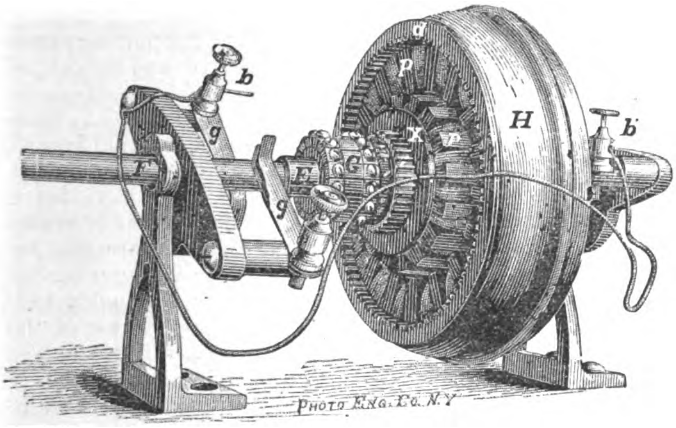

FIGURE 1.

corresponds to the armature of a dynamo machine, and revolves as 3 to 1 of the outer ring, which latter in turn corresponds to the field of a dynamo, figure 1. Their relative speeds are maintained through the agency of an epicycloidal train of either friction or toothed gearing, the internal gear being carried by the outer ring or field, while the central, or " sun-wheel," is mounted upon the hub of the armature with an intermediate friction clutch. The intermediate or floating wheel is carried by a frame, forming one with, or rigidly attached to, the car axle boxes. Thus do all geared parts move together always in line. The armature is mounted upon a hub in the form of a sleeve, which revolves upon the car axle.[2]

Here we have the weight of the machine directly at the point of traction—the tractive power is distributed to every wheel, and thus applied directly to the point of traction. The armature may revolve independently of the wheel—hence it may be allowed to attain a high velocity before applying the load, which can be applied slowly, and advantage be taken of the impetus of the armature to overcome the inertia of the car on starting. Thus also are we not obliged to jeopardize the life of the armature. Again, we are by this arrangement afforded a purely mechanical means of controlling the speed of our car without introducing useless resistance, since by allowing a slip at the friction clutch the armature will run at a proportionately higher speed and generate a higher counter E. M. F., which acts as a resistance and allows less current to pass through the machine, while at the same time the machine is working more efficiently, since its E. M. F. is approaching nearer the E. M. F. of the generator or line. In moving the field as well as the armature we produce an effect equivalent to increasing by one-third the number of sections in the armature beyond what is mechanically practical, and thus do we raise the electro-dynamic efficiency of the motor. The construction of the motor also is such as to greatly increase the leverage through which the work is done, the pull between the armature and the field being at a considerable distance from the centre. Again, the electro-magnetic construction is such that the armature and the field are subjected to each other's inductive influence throughout their entire length.

This animated wheel is particularly well adapted to one-rail elevated roads, and there is no telling what speed might be attained with wheels like this of from 4 to 6 feet in diameter. In another form I have taken the field from the wheel, and made it stationary around the axle between the wheels, the armature revolving as before on the axle, the whole forming an electric truck, see figure 2, which is in no way attached to the car, and which may therefore be removed from under or placed beneath a car at pleasure in a few minutes. Here, also, all parts are in line and move together, since the field is rigidly attached to and forms one with the car-axle box. The power is here transmitted

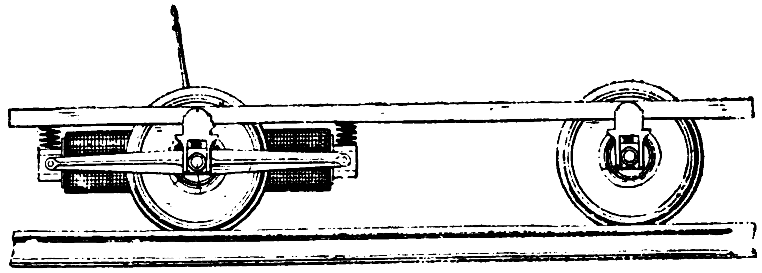

FIGURE 2.

through an epicycloidal train of friction gearing at each end of the armature.[3]

We come now to a detailed consideration of the question of percentage of return. The return of a " dynamo " machine with regard to another which puts the first in motion is expressed by the proportion of the useful mechanical work developed by the second to the work absorbed by the first. This may be estimated in two different ways: First, by applying a dynamometer to the generating machine and a Prony brake to the motor; second, by measuring the intensity or quantity of the current traversing the two machines. In the latter case the mechanical work absorbed by the first machine and that returned by the second may be ascertained by the electric measurements taken, if we but apply certain fundamental dynamic theorems. Of necessity, such a return would be somewhat higher than that obtained by direct mechanical measurements, since it is simply that which we should obtain in practice if the two machines were perfect, that is, free from friction and certain electric imperfections. Unlike the steam engine, however, which returns us but 10 per cent of our energy in the form of available work, we get in the electric engine a return of 90 per cent, the above-mentioned sources of loss consuming but 4 or 5 per cent. By Joule's law we can easily calculate the mechanical work developed in the form of heat in an INERT circuit. This is expressed by one of these three formulæ, $R\,I^2$, $\frac{E^2}{R}$ or $E\,I$.

The first supposes the resistance (R) of the circuit and

2. The lecturer here showed several models in operation.

3. The electric railway truck was here shown in operation, see figure 2.

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the quantity (I) to be known; the second supposes the electromotive force or pressure (E) and the resistance (R) to be known; and the third supposes the electromotive force (E) and the quantity (I) to be known. The last two may be deduced from the first, observing Ohm's law $I = \frac{E}{R}$.

Suppose, now, that instead of the circuit being INERT it contained a perfect electric motor (of the Pacinotti type) free from friction, etc., and provided with a brake.

The total energy developed by the source of electricity now appears in the whole circuit in two different forms: heat and work. The quantity of the current being the same throughout the circuit, the heat developed in the whole circuit is expressed by $\frac{R I^2}{g}$.

The total quantity of the work generated and expended in the circuit is expressed in kilogrammetres per second by $\frac{E I}{g}$.

Supposing, now, T to be the mechanical work produced by the motor expressed in kilogrammetres per second. Then, since the total energies developed by the source equal the sum of the partial energies developed in the whole circuit, we have the equation $\frac{E I}{g} = \frac{R I^2}{g} + T$; whence it follows that we have $T = \frac{I(E - R I)}{g}$, where $E - R I$ represents a negative E. M. F. (e). Hence we conclude that where a motor performs work it necessarily generates a counter E. M. F., and this experiment proves true.

We are now, therefore, brought to the equation $T = \frac{e I}{g}$, or remembering that $I = \frac{E - e}{R}$ $T = \frac{e(E - e)}{g R}$, so that the total energy developed by the source becomes $I = \frac{E I}{g} = \frac{E(E - e)}{g R}$, and the work lost in the form of heat $\frac{R I}{g}$ or $\frac{R}{g}\left[\frac{E - e}{R}\right]^2$ or $\frac{(E - e)^2}{g R}$.

These expressions constitute the fundamental equations of the theory of the electrical transmission of power. Dynamometric measurements have of late proved that the expression $\frac{E I}{g}$ represents about .95 of the mechanical work applied to the pulley of the generator after deductions are made for the work expended in overcoming friction; that is to say, if the total work applied to the generator is represented by 100, and the work absorbed by friction by 10, the product $\frac{E I}{g}$ may reach $\frac{95}{100}$ of the remaining work ($100 - 10$) absorbed in purely electric work, or 85.5 per cent. The difference, $90 - 85.5$, then represents the loss due to electric imperfections, which I have already said amounted to 4 or 5 per cent.

These fundamental equations enable us to calculate the value of the economic return. For if we call k this return, then $k = \frac{e I}{g} \div \frac{E I}{g} = \frac{e}{E}$.

You notice, then, that this expression is *independent* of the *resistance* (R), so that we may conclude that the economic return depends only upon the proportion between the counter electromotive force of the motor and the positive electromotive force of the generator. This is what M. Deprez tersely expressed when he said, "The return is independent of the distance." The *absolute work*, however, is not independent of the distance. If we would maintain constant the work transmitted, whatever the resistance or distance, M. Deprez has shown that the electromotive force of the source must be increased proportionately to the square root of the resistance. It is a misunderstanding of this point which has led some superficial critics to dispute the results of M. Deprez's work. No rational person would advocate the possibility of transmitting the power of Niagara over a telegraph wire for an unlimited distance. Neither can I conceive of an instance where one would think of putting in a plant to transmit 10 h. p. over a telegraph wire to a point distant 25 miles from the source. Surely no one would think of establishing a plant for the hydraulic or pneumatic transmission of 10 h. p. to a point distant 25 miles. Why, then, should such absurdities be expected of electricity? In order to see the influence of resistance in the circuit on the absolute work, we must introduce into these equations the value of the return k which it is *desired* to obtain. From the equation $k = \frac{e}{E}$ we have $e = k E$, and making use of this value e in the preceding equations, they become:

Work absorbed in generator, $\frac{E^2 (1 - k)}{g R}$

Work recovered in motor, $\frac{E^2 k (1 - k)}{g R}$

Work lost in the form of heat, $\frac{E^2 (1 - k)^2}{g R}$

Thus the absolute work of the receiver may be the same in two different experiments, although the economic return

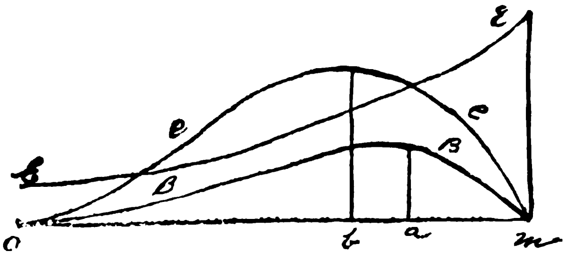

FIGURE 3.—KNAPP'S DIAGRAM FOR POWER AND EFFICIENCY.

[Speeds are plotted as abscissæ, and the electrical work absorbed in watts divided by 746 as ordinates. Then with series wound motors we obtain curve $E E$, the shape of curve depending on type of motor. Variation of speed obtained by loading brake with different weights. Maximum speed $O M$. There is a speed at which the external work is a maximum. After loading the brake with varying weights, plot resulting speeds and h. p. as abscissæ and ordinates, which produces the curve $B B$. $e = \frac{B}{E}$ made with arbitrary scale gives commercial efficiency. Speed for maximum external h. p. is $o\ a$. Speed for highest efficiency is $o\ b$.]

has very dissimilar values. These differences result from the weight put on the brake. According as the weight on the brake is great or small, so the speed of the receiver is low or high, but the work per second may be the same. This work also may be nil in two cases—when $k = 0$, and when $k = 1$.

This diagram, figure 3, very beautifully illustrates geometrically the relationship which exists between the work done and the efficiency, as also the relationship between e and E.

We see from this that there is a value for the economic return, for which the useful work of the motor is the greatest possible. The sum of the two expressions k and $1 - k$ being constant, this maximum is reached when they are equal; that is to say, when $k = \frac{1}{2}$. This further gives the

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result $\frac{E^2}{g\,R}(1-2\,k)$ of the second term of the second equation. The useful work received therefore becomes $\frac{E^2}{4\,g\,R}$, and the work spent in the generator $\frac{E^2}{2\,g\,R}$. If the receiver were prevented from turning we should have $k=0$, and the work absorbed by the generator then becomes the greatest possible, or $\frac{E^2}{g\,R}$, the identical value we found for an inert circuit. From this we see that the maximum mechanical work developed by the receiver corresponds to the economical return, being equal to one-half, and that when the economic return is varied between 1 and zero the work spent in the generator constantly increases from zero to $\frac{E^2}{g\,R}$, although the electromotive force remains constant.

It is from not having well comprehended these simple considerations that many have lately written a vast amount of inaccurate criticism on the electrical transport of force. For example, one of the most common of errors is the belief that the economic return can never exceed 50 per cent, because it reaches this value when the work developed by the motor or receiver is the greatest possible in value. We have analogous conditions in thermodynamics, why not apply such reasoning in their case? Take a case in point, now, of two precisely similar machines, one acting as generator, the other as motor. Remembering that the current is equal throughout the circuit, and that a constant current produces a uniformly constant field, and that the E. M. F. of a particular generator depends upon its speed and the strength of its field, then it follows that calling the corresponding electromotive forces and speeds of the two machines e, E and v, V respectively, and k the return, we shall have $\frac{e}{E}=\frac{v}{V}=k$. We thus come back to the value $\frac{e}{E}$, which we have already obtained for the economic return by quite a different method.

Regarding the recent experiment of M. Deprez, when it is remembered that before this experiment the boldest enterprise in this direction was a 4-millemetre *copper* wire, 6,400 metres long, with a resistance of only 8.4 ohms, carefully insulated throughout its entire length, and that M. Deprez chose an iron telegraph wire exposed to the rain, 114,000 metres in length, with a resistance of 950 ohms, and that notwithstanding these enormous differences in the conditions of the two experiments, the same industrial return was obtained, namely, 50 per cent, it will be conceded that the Miesbach-Munich experiment was of the utmost importance in the history of the transport of force. In this experiment, notwithstanding the high electromotive force employed (1,400 volts) and the poor insulation of the line, not 1 per cent of the current was lost by leakage. It is extremely unfortunate for the engineering profession and the people at large that M. Deprez has been so misunderstood, for it has resulted in the creation of some very erroneous impressions in the minds of some engineers concerning the electrical transmission of power. Let me cite an instance in point: Perhaps some of you have noticed a paragraph going the rounds of your journals to this effect: "M. Deprez has succeeded in transmitting a current of electricity equivalent to 5 h. p. along a telegraph wire one-sixth of an inch in diameter, some ten miles long, with an expenditure of 29 per cent of the power. Compared with wire rope, this means falls short in actual *efficiency*" (mark you, *efficiency*), "since Messrs. Hems send 500 h. p. along a ¾-inch rope." Such logic is ridiculous, and should not find place in scientific journals. Pray tell us, in the first place, what has the *efficiency* to do with the respective sizes of the conductors in the two systems; and, second, one might as well impose upon the teledynamic advocates that they transmit their 500 h. p. by means of a ¾-inch twine, as to impose upon the advocates of electrical transmission the necessity of using an iron wire one-sixth of an inch in diameter for the transmission of the same power. As a matter of fact, we can transmit electrically 1,340 h. p. over a copper conductor of but half an inch in diameter a distance of 5 miles with a loss of but 10 per cent. in the line. Aside from the difficulties attending its subdivision and application, the transmission of such an amount of power by a wire rope of like size and over a corresponding distance would be impossible.

We come now to a practical application of these data.

Suppose we wish to determine whether it will pay to operate a street railway by electricity: Knowing the h. p. which the motor must develop in order to move each car or train over the given maximum grades at a given speed, and knowing the greatest current the conductor we provide can carry without losing more than the prescribed amount, it remains to calculate the electromotive force which the motor must develop.

Supposing the electrical efficiency of the motor to be 85 per cent, then $H=\frac{Ie}{746}\times\frac{85}{100}$; because the counter E. M. F. (e) generated by the motor multiplied by the current traversing it measures the *electrical* work it performs. Then

$$e=\frac{H\times 746}{I}\times\frac{100}{85}.$$

In order to find the E. M. F. of the generator (E):

$$\frac{E}{e}=\frac{W}{w}=\frac{Ie+I^2R}{Ie}=1+\frac{IR}{e};\quad E=e+IR.$$

Upon these and the preceding expresssions are based the following estimates as to the comparative cost of operating a street railway by horse-power, electricity, and cable:

COST OF OPERATING ELECTRIC SYSTEM.

44 cars. Speed, 6 miles. Length, $5\frac{68}{100}$ miles.

Twenty-two cars acting as locomotives, each one having an additional car attached, and being provided with 8 h. p.

Twenty-two cars, 8 h. p., multiplied by 2, on the supposition that we get but 50 per cent return, instead of 70, as is possible, = 352 = total h. p. consumed when all the cars are running and consuming full 8 h. p., a condition which never exists, even when the road is working at maximum capacity.

First item—	
Average power consumed during the running hours	200 h. p.
Pounds of coal consumed per h. p. per hour	2½
Total amount of coal consumed per hour	500 lbs.
Working hours per day	20 hours
Pounds of coal consumed per day	10,000 lbs.
Cost of coal per 1,000 lbs., $1.	
10,000 lbs. of coal at $1, $10 = cost of coal per day.	
Cost of coal per year	$3,650
One engineer at $5 per day	$5 00 per day
One assistant engineer at	2 50 per day
One electrical engineer at	5 00 per day
One assistant electrical engineer at	2 50 per day
Two stokers at $2.50	5 00 per day
Second Item—	
Total cost of labor at station per day	$20
Yearly cost of labor at station	$7,300
Third Item—	
Yearly oil and waste	$500
Fourth Item—	
One conductor to every 2 cars at	$2
One driver to every 2 cars at	2
Cost of labor on each train	$4
Number of trains	22
Total cost of labor on cars per day	$88
Total yearly cost of labor upon cars	$32,12

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Three steam engines of 208 h. p. each	$7,500
Fittings for same	1,500
Two Babcock & Wilcox boilers of 460 h. p.	8,500
One Babcock & Wilcox boiler of 146 h. p. capacity	4,070
Fittings for boilers	1,000
Extras	1,000
Total net	$23,570

Four electric circuits of 2¾ miles each, having conductors with electrical capacity of 500 ampères and having a resistance of but one-fifth of the entire line, where each generator and each motor has a resistance of 10 ohms, and of which there are 11, arranged in multiple circuit, equal a copper bar of half an inch in area, costing, at 30 cents per pound:

Cost of copper conductor per mile	$2,890 60
Number of miles	11
	$31,790 00
Cost of conduit and tramway per mile of double track	$40,000 00
	2¾
	$110,000 00
Electro-motor fittings to 22 cars at $1,000 each	$22,000 00
Twenty-two electric generators at $2,000	$44,000 00
Four surplus generators	8,000 00
Total cost of generators	$52,000 00
Wear and tear on item of motors at 8 per cent	$1,320 00
Wear and tear on generators at 4 per cent	2,000 00
Wear and tear on engines and boilers	3,000 00
Wear and tear on cars, conduit and tramway	11,000 00
Total yearly wear and tear	$17,320 00
Wear and tear of conductor	Nothing
Forty-four cars	$50,000 00

Yearly Running Expenses.

Fuel	$3,650 00
Station labor	7,300 00
Waste and oil	500 00
Labor on cars	32,120 00
Wear and tear as itemized	17,320 00
Total	$60,890 00
Yearly interest on capital invested	17,361 60
Yearly expenses, including interest	78,251 60

Capital Invested.

Motors	$22,000 00
Generators	52,000 00
Engines and boilers	23,570 00
Electric conductors (copper)	31,790 00
Conduit and tramway	110,000 00
Forty-four cars	50,000 00
Total	$289,360 00
Interest at 6 per cent	17,361 60
Present yearly earnings of road upon which this estimate is based	$177,000 00
Above estimates suppose the work done to be doubled, and, consequently, the income doubled, making	$354,000 00

PRESENT COST OF OPERATION WITH HORSES.

Estimated from Data Furnished by a Railway Company—Details of Estimate.

Twenty-two cars, earning capacity	$177,000 00
Capital invested	$225,000 00
Interest at 6 per cent	13,500 00
Wear and tear at 10 per cent on invested capital, less cost of horses, the wear and tear of which is included in item of $11,710.20; allowing $25,000 to be deducted from the $225,000 as the cost of horses, leaves as invested capital to reckon 10 per cent wear and tear upon	$200,000 00
Interest at 10 per cent	20,000 00
Feed	$31,689 60
Running expenses of stables and contents	11,710 20
Stable expenses	2,185 20
Blacksmithing	2,356 20
Total	$47,941 20
One conductor on each car at $2 and 1 driver at $1.50, 22 cars, cost of labor on cars per day	$77 00
Yearly cost of labor on cars	27,874 00

Result—

Interest at 6 per cent	$13,500 00
Wear and tear on $200,000 at 10 per cent	20,000 00
Total cost of propelling power	47,941 20
Yearly cost of labor on cars	27,874 00
Total yearly running expenses	$109,315 20
Will average about	115,000 00

COST OF OPERATING CABLE SYSTEM.

The amount of coal consumed on the Clay Street Railroad is 3,600 lbs. per day of 17 hours, costing $8 per ton.

Cost of Cable Road Construction.

Will average per mile of double track	$200,000 00
Three miles	600,000 00
Two horizontal engines, 14 inches by 30 inches, set up	5,800 00
Two boilers, 52 inches by 16 feet, set up	4,500 00
Tank, pump and heater	1,500 00
Compensating arrangement at end of line	1,800 00
Driving machinery, pulley, etc	6,500 00
Twenty-two cars at $1,000	22,000 00
Twenty-two dummies fitted with grips, at $900	19,800 00
Engineering sundries, at 10 per cent, in round numbers	25,000 00
Total cost of 3 miles complete	$686,900 00
Interest at 6 per cent	41,214 00

Cost of Operation.

Maintaining cable per year		$15,000 00
Oil and waste		500 00
Maintaining conduit, tramway, and cable-bearing sheaves, 10 per cent on $600,000		60,000 00
Interest on capital invested, at 6 per cent		41,214 00
In round numbers, 600 tons of coal, at $8		4,800 00
One engineer at $5 per day, one assistant engineer at $3 per day, two stokers at $2.50 per day—labor of station per day	$13 00	
Yearly cost of labor at station		4,745 00
Cost of labor per day, 22 trains	$88 00	
Yearly cost of labor upon cars		32,120 00
Total yearly cost of operation		$158,379 00

COMPARISON OF RESULTS.

By Electricity.

Capital invested	$289,360 00
Earning capacity	354,000 00
Running expenses, including interest	78,351 00

Power consumed, and, consequently, cost of operation, more nearly proportionate to the work done, or the EARNINGS.

Great flexibility, rendering it possible to exactly adapt the capacity of the road to the varying demands.

After plant is once established, but little attention is required outside of keeping same in repair.

Amount of attention and care given to machinery manifest on the surface.

Great flexibility (that is, power to change the capacity of the road to suit varying traffic), rendering overcrowding unnecessary, and the road more *popular*, and therefore more generally patronized.

Power may be distributed throughout the district amounting to 2,000 h. p. with the same street plant and but little increase in yearly expense, bringing in an additional income of over $30,000 a year.

Engine can be reversed and cars stopped almost instantly. Curves may be made without any additional loss in transmission. Speed unlimited.

By Cable.

Capital invested	$686,900 00
Earning capacity	354,000 00
Running expenses, including interest	158,379 00

Capital confined to street railroading.

If the cable breaks the entire system is crippled, unless we use a double cable, which means still greater wear and tear and additional capital invested, upon which interest must be allowed.

Can run cars in but one direction.

Variation in speed effected at the expense of excessive wear and tear.

No engine to reverse, and, consequently, the cars cannot be stopped so suddenly.

Curves are made only with excessive loss. Speed necessarily limited. Steeper grades, however, may be ascended than would be possible under the horse-power or electric systems.

By Horses.

Capital invested	$225,000 00
Earning capacity	177,000 00
Running expenses, including interest—best year out of 10	109,315 20

Power consumed, and, consequently, the cost of operation, the same whether you carry 3,000,000 passengers or 2,000,000.

Want of flexibility as regards power to regulate the capacity of the road in accordance with the varying demands at different periods throughout the day.

More details to attend to—such as buying and disposing of horses—all of which makes more clerical work, and largely occupies manager's personal attention.

More at the mercy of unscrupulous employés, as regards the attention they give the horses.

Want of flexibility of the system renders it necessary to at times overcrowd the car, and thus is the road made unpopular.

Capital confined to street railroading.

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RAILROAD TELEGRAPHS.[1]

BY CHARLES PAINE.

The telegraph has become the indispensable ally of the railroad; by its aid the capacity of a single track is doubled, and that of a double track may be very much increased; aside from its use in the movement of trains, it facilitates the rapid transaction of business to such an extent that it has become quite as important an aid to the commercial as to the operating department.

It has been sometimes attempted, even upon roads of considerable traffic, to do the business of all departments upon a single wire, no doubt from a mistaken idea of the capacity of the wire rather than from a failure to appreciate the advantages of a prompt service. It would be a grave error to allow any other business to hinder the despatching of trains, or even to interrupt it; for it will not do to confuse a telegrapher, during the transmission or receipt of train orders, by hurrying him with other matters.

It is best for a new road to build its own telegraph line, and to operate it, at first; in the rapid construction of a new road, it would be found of great advantage to erect the line as soon as possible after the location of the road had been finally determined; for the benefit derived from constant and instantaneous communication with headquarters would more than pay the extra cost of building it without the aid of railroad transportion. If the line were not too long, it could be temporarily equipped with telephones instead of telegraphic instruments, which would postpone the employment of skilled telegraphers for a while; a distance of one hundred miles or more can be talked through very satisfactorily at the present time; and with the improvements which are announced every few days, we may expect to talk well through a thousand, before long. The cost of building a telegraph line is not very considerable for a railway company, and a better bargain with any telegraph company for connections, for interchange of business, or for operating the line jointly with the railway, can be made after the telegraph line is completed than before. It should, however, be a thoroughly well built line, upon the best model up to date. The poles are larger and longer on the best lines, the wires are of greater diameter and of better material than they were a few years ago. This is the result of a long experience with lines of an inferior character; they cost more to keep in repair than good lines and were not to be relied upon. The size of the poles is perhaps the most important feature of a new line; for that limits the number of wires which can be strung upon them, and, as it is very sure that they will be loaded to their full capacity within a few years, it is best to set up those of the largest size which are now used in the best practice of the older telegraph companies. Cedar poles are regarded as best of all; white oak, chestnut and yellow pine are very good, where more conveniently obtained. The standard length of telegraph poles was formerly 24 ft.; it was found that after the part in the ground had decayed, that which had been above ground was still good. This led to the adoption of 30 ft. as the usual length, permitting the poles to be cut off at the ground when decayed, and to be reset. From 32 to 36 poles per mile is the number required. On some roads the telegraph poles serve as mile-posts, boards with the proper figures upon them being nailed to the post which is nearest to the mile-stake. By attention to this in building the telegraph line, or by resetting the poles at the mile stakes, the position of these could be cheaply perpetuated and the cost of mile-posts avoided. If, then, the intermediate posts were somewhat carefully spaced, they would be of very great convenience as reference stakes for the track department; if those at the mile stakes were to be painted white for their whole length, and those at the half and quarter miles for only a part of their length, they would afford a scale of distances which could be read in passing at the highest speeds, and be of value to the officers of the road in many ways.

The ordinary cross-arm is calculated for six wires; if it is probable that arrangements will be made with a telegraph company for connections and for the use of the railroad's right of way, it will be wise to put a second cross-arm on the poles before they are set, and to have the *gains* cut in the poles for a third cross-arm; for such work can be more easily done before the poles are set than after.

But these remarks are not applicable to an obscure branch line in an unsettled country, where possibly a single wire will serve the railway and telegraph companies both, for some years.

When possible, the poles should be set more than their length from the main track, so that if they should fall from any cause they will not obstruct it. If there are more passenger stations upon one side of the line than the other it will save crossings of the tracks, which are objectionable, if the poles are set upon the station side. In marshes it is frequently difficult to maintain a telegraph pole erect because of the softness of the ground. This can generally be accomplished by sinking a barrel without any head where the pole is to stand, then setting up the pole inside the barrel and filling between the pole and barrel with gravel or small stones.

Insulators of many varieties have been experimented with, and there are several especially fitted for peculiar situations; nothing has been found to be better for general use than the cylinder of glass screwed on to an oaken pin, a coarse thread being molded in the glass to correspond with a similar one on the pin.

No. 9 wire was formerly universally used for telegraphic purposes, now No. 6 has the preference for long lines, and No. 4 has its advocates; this refers to iron wire, of which none but the very best is fit. There are several kinds of wire of greater conductivity invented and experimented with; none established as equal to iron for main lines, as yet.

It is not intended to treat of the manifold applications of electricity to railway working; words would be wanting to represent their value and convenience; space would be lacking in which to simply mention their variety; there are excellent books on train despatching, on block-signaling, and many other special uses which should be studied by those who wish to be informed. Unfortunately, the currents from a battery are not of sufficient strength to do much work; they can sound a bell or move a hand upon a dial, conveying almost any information by concerted signals; they may be arranged to set other more powerful forces at work at any distance, and in this way render very important service in signaling. It should be oftener remembered that we have at hand this power of notifying in advance the approach of trains, whenever it can contribute to safety or convenience to do so; and at a trifling cost, even by means which are automatic, so that there is no attendant required. The incessant whistling in great yards might be totally dispensed with, and much more certain information conveyed by a line of bell signals at the switchmen's cabins. Telephones should communicate between the offices and the principal points in all important yards and termini; indeed, they can scarcely be placed upon a railway where they will not repay their cost by facilitating the transaction of business.

In the construction of its telegraph line a railroad company will need the services of experienced men, as well as in its use and maintenance afterwards. The setting of the poles, the stringing of the wires and other particulars of the work can be accomplished by experts in a fraction of the time that persons without practice would require. As in all other departments the first requisite is an energetic superintendent who thoroughly understands the details of the building and testing of a line, as well as the art of telegraphing. It will be of great advantage if he also knows something of modern progress in electrical science.

1. The *Railroad Gazette.*

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Telegraph offices should be well lighted by night, which is much neglected, as well as by day; and they should be well ventilated, because there are fumes from all varieties of moist batteries, which taint the air in addition to the ordinary causes of vitiation; they should be contrived so as to exclude the public and loafers from the apartments in which are the operators and the messages. Upon railroads, there is a disposition among all classes of employés to make the telegraph office a sort of club-room, probably because they can there learn the latest news; and on the part of the telegraphers there is a natural inclination to relieve the tedium of their office hours by social chat. It is, however, due to the accuracy and privacy of this most important mode of correspondence and of giving orders, that the telegraph office shall be entered only by the telegraphers; as little as possible even by the higher officials, who can set a good example by remaining outside, unless they must enter upon business.

ELECTRIC SIGNALING APPARATUS ON THE WEST SHORE RAILROAD.

Mr. J. E. Childs, General Superintendent of the New York, Ontario & Western Railway, has sent to Thomas W. Spencer, C. E., Inspector for the New York Railroad Commissioners, an account of the various electric and pneumatic signals applied on the 13 miles of the New York, West Shore & Buffalo Railway south of Cornwall, from which we take the following:

This portion of the track, used by the West Shore and the Ontario & Western companies, lies along the foot of Dunderberg, Storm King, Cro' Nest, and other mountainous regions of the Highlands of the Hudson, where the rocky cliffs on the one side and the very deep water on the other, necessitate considerable curvature. In some cases the water in the river was 90ft. deep, only 20 ft. from the shore, with bottom of shelving rock, where we were unable to make an embankment, and were obliged in several instances to put in long spans of iron bridges. We also have on this 13 miles two jack-knife draw-bridges, one cantilever bridge, one tunnel and the sharpest curves (though very short) upon the road. It was considered advisable on account of these features of this portion of the line, to place upon it the best system of automatic signals that could be found. Mr. George Westinghouse, of Pittsburg, having just procured letters patent upon his new automatic, electric and pneumatic block signals, we arranged with him to equip this 13 miles. The power for compressing the air is furnished by two 10 h. p. engines, located near either extremity of that portion of the line which is covered by the block signals. The air after being compressed is passed through coils of pipe and two cylinders where it is cooled, and is sent through a pipe 1 in. in diameter which is laid between the tracks. At intervals of three-fourths of a mile we have established semaphore signals for each track. These signals are located at points where they can be seen for the greatest distance, and are connected by a pipe with the main air-pipe lying between the tracks. The signals are operated by compressed air cylinders, the valves of which are controlled by electric currents, one of which passes over the line on telegraph poles and the other through the rails. The signals are controlled by short circuiting electric current in the rails when a train or engine passes over the track, the current passing through the wheels and axles from rail to rail. Opposite each semaphore signal is a battery well, built of brick below the surface of the ground, and containing for each semaphore signal a 7 jar battery. When a train passes into the block the signal immediately behind the train shows both arms at a horizontal position by day, and two red lights at night; this is called an absolute danger signal, or the second danger position. The second signal from the rear of the train shows the upper arm in an inclined and the lower arm in a horizontal position by day, and a red and white light by night; this is called the first danger position. It will be seen that by this system when one train follows within one mile and a half of another, it is warned that a train is preceding it, and the first appearance of the signal not only indicates danger but absolutely locates it. For instance, if the engineer sees a signal with the upper arm inclined and the lower arm horizontal, or showing a red and white light, he knows that a train is ahead of him, but that the block immediately ahead of this signal is clear and that the train or obstruction is upon the second block. If he sees a signal with both arms projecting in a horizontal position, or showing two red lights, he knows that the danger is imminent and that a train or obstruction of some nature is upon the block ahead of this signal. A book of instruction is furnished to employés, which, without describing the details of the signals at all, gives them all the information which they require and shows the simplicity of the system.

In addition to this, every switch upon this portion of the line is interlocked with the circuit in the track in such a manner that whenever the switch is opened two danger signals are shown upon the main track from which the switch is turned. The electric current also passes into the rails of the side-tracks out to the clearance distance, so that, should a car standing on the side-track be moved by malicious persons, or should it be blown by the wind to a point where it might interfere with the traffic, two danger signals are immediately placed automatically upon the track in the direction from which the trains approach. We also have two draw-bridges which are connected with this system in the following manner: The two jack-knife bridges on this portion of the line are connected with this system without changing the form of the automatic signals, two of them being made to act as distance and home signals for the draw-bridge. When a train approaches within 8,000 feet of the bridge, an electric bell is sounded continuously directly over the head of the watchman who attends to the draw-bridge, warning him that the train is approaching and that he must not open the draw. This bell rings from the time the train passes over a point 8,000 feet, until it passes a point 7,000 feet from the draw-bridge, when the gong ceases to sound. If, during the time the train is running from the 8,000 ft. to the 7,000 ft. point, the watchman should, contrary to instructions undertake to open the draw-bridge, he cannot do so without first setting two danger signals in the face of the train, while the train is still one and one-half miles distant from the bridge. After the train has passed over the point 7,000 feet from the draw-bridge the draw is locked by electricity and cannot be opened. As these draw-bridges are on double track the signals operate in the same manner for both directions. This I consider a very perfect system for the protection of a draw-bridge, and I could suggest only one improvement which we are now considering; that is, to have a switch near the draw-bridge, which shall throw the train off the track rather than let it into the draw in case the engineer disregards the signals. We also have some crossings protected by electric bells which ring at the crossing when a train approaches from either direction within one mile, and the bell continues to ring until the train has passed the crossing. We also have, aside from the block system, an electric tunnel block signal, protecting trains while passing through the Haverstraw Tunnel, which works automatically. When a train reaches a point within 200 feet of the tunnel, by short-circuiting an electric current in the track, a larger signal is set in the rear of the train which remains at danger and prohibits other trains from entering the tunnel until this train has passed entirely through and 200 feet beyond the tunnel, when the signal goes to safety.

During the month of October 1,065 trains passed over this portion of the line. There are in all 45 signals, including the home and distance signals for the draw-bridges,

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making 47,925 signal movements during the month. From the attached report you will see that the total number of failures during this period was 68, including Oct. 28, when a break occurred in the main pipe at Fort Montgomery, which set all signals at danger—or about one-seventh of one per cent. You will observe that with only one exception the signals went to danger and consequently caused no harm other than a slight delay to traffic.

These signals have been in operation since April 1, 1884, and in that time but two failures of the signals where they were at safety and should have indicated danger have been reported. You will also observe that a number of failures occurred through broken battery jars. We found those jars were too light, and are now substituting heavier ones.

You have no doubt, seen reported in the papers that an engine ran into Popolopen draw-bridge in the month of October. This was not through any fault of the signals, as the engineer admitted, having passed the distance signal 7,000 feet and a home signal 650 feet from the draw, both set at danger. From experiments recently made, I believe that this 13 miles of automatic block signals can be operated with one engine located at a point about the centre of the system, and I shall make this change in a few weeks, which will reduce the cost of operating the signals.

THE GALVANOMETER OF D'ARSONVAL AND DEPREZ.[1]

Galvanometers of innumerable kinds abound, and each form has some special merit which renders it useful for certain restricted services. The old astatic instrument of Nobili is still preferred by many to the more modern mirror galvanometer of Sir W. Thomson because it requires no lamp, and can be used without darkening the room. The tangent galvanometer still holds its own in the testing-room for simple tests; and the lineman's detector is still indispensable on the score of its portability. For commercial purposes, where strong currents and steady potentials have to be measured, the newer ampère-meters and volt-meters have displaced the older forms of instrument. But still there is no best galvanometer of universal adaptability, even the Siemens "universal" galvanometer being too clumsy to meet with general favor.

For the purposes of the private laboratory a galvanometer is desired which shall be sensitive, yet accurate in its indications, capable of being used for measuring currents of all kinds, weak and strong, and of measuring differences of potential from the thousandth of a volt to a thousand volts. It ought to be capable of being used in broad daylight; of being rapidly read off; and it ought also to be independent of external magnetic disturbances. The annoyances which arise from the last two causes when working with sensitive galvanometers are only too well known. The needle of the instrument once deflected continues to oscillate for half a minute, perhaps longer, causing vexatious delays, and when perhaps it has settled down at last to zero, some person in the next room moves a piece of iron—a poker, a penknife, or some other magnetic object—causing the zero of the instrument to change. An aperiodic dead-beat instrument, not subject to external magnetic forces, would be a boon indeed.

A galvanometer which, without being absolutely perfect, goes very near to fulfilling these desirable conditions has lately been put into the hands of electricians by M. Carpentier, of Paris, successor to the well-known Ruhmkorff. It is the invention of M. Marcel Deprez as modified and improved by Dr. d'Arsonval. The many novel features which it presents would of themselves justify its description in the pages of *Nature*; and the general excellence of its performance, of which the writer of these lines can personally testify, is already widely acknowledged.

The main peculiarity of the new instrument lies in the fact that, whereas in almost all galvanometers there is a fixed coil and a movable magnetic needle, in this galvanometer the coil is movable and the magnet—no longer a mere needle but a substantial compound horse-shoe of steel—is fixed. Figure 1 represents the instrument itself. The steel magnet, made of three thin horse-shoes each magnetized as strongly as possible, is firmly fixed to a metal base, with its poles upwards. Between the poles hangs the coil, rectangular in form and extremely light, held in its place by a thin silver wire above and another thin silver wire below. This coil is made by winding on a rectangular core, which, after the strands have been cemented and bound together, is removed, leaving the wire only. It weighs only a few grains. To reinforce the magnetic field a small cylinder of soft iron, small enough to lie in the hollow of the suspended rectangular coil without touching it, is placed between the poles and is rigidly supported from behind. The coil is then free to turn in the very narrow space between the iron core and

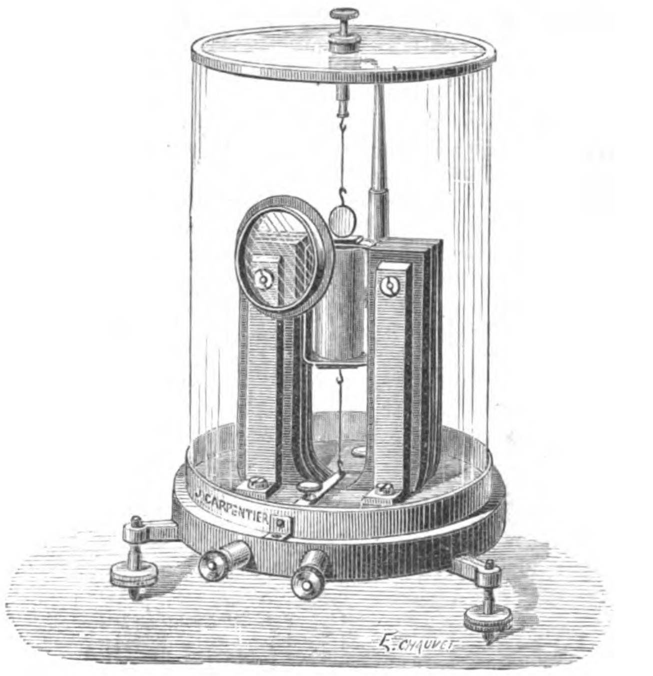

Figure 1.

the external magnet-poles; and it need hardly be added that this contrivance produces a very intense magnetic field. The current is led in by one of the silver suspension wires, and leaves the coil by the other. So far the arrangement precisely resembles that adopted in the well-known "siphon recorder" of Sir W. Thomson, invented twenty years ago for the purpose of cable-signaling. A small mirror of 1 metre focus is affixed to the suspended coil; a brass spring at the bottom keeps the suspending wires adequately stretched; and a screw-head at the top of the instrument serves both to regulate the tension in the wires and to let the coil down, to a position of rest on the central iron cylinder, whenever the galvanometer is to be dismounted for removal to a distant place. The resistance of the coil is about 150 ohms in the ordinary pattern of instrument. As there is no suspended needle, no external magnetic forces affect the zero of the instrument; and, since the position of the coil is determined solely by the elasticity of the suspending wires and the magnetic action of the fixed magnet on the current in the coil, it can be used in any position, and is independent of the earth's magnetic field. It can even be placed quite near to a dynamo machine. The intensity of the magnetic field in which the coil is situated is such that whenever the galvanometer circuit is closed—even through a consider-

1. *Nature.*

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able resistance—the motion of the needle is dead-beat. It takes less than *one second* to come to rest at its final position of deflection, and when it returns to zero it does so with the most complete absence of oscillations. The spot of light on the scale never oscillates so much as 1 millimetre over the zero on releasing the galvanometer key.

The optical arrangements adopted by M. Carpentier are shown in figure. 2. The instrument is set with its three leveling screws in three V-grooves in a convenient bed-plate. Opposite it is set a semi-transparent scale of celluloid, 50 centimetres in length, graduated in millimetres. The light is provided by a single wax candle held in a holder like a carriage candle, which also carries a paraboloidal mirror back. This candle is set so that its light falls upon a small adjustable plane mirror fixed to the back of the scale. This mirror reflects the ray upon the small mirror of the galvanometer, but as it passes beneath the scale it traverses a square aperture across which a thin wire is stretched vertically. To see the spot of light the observer stations himself in front of the scale, so as to see the light coming through the strip of celluloid. He

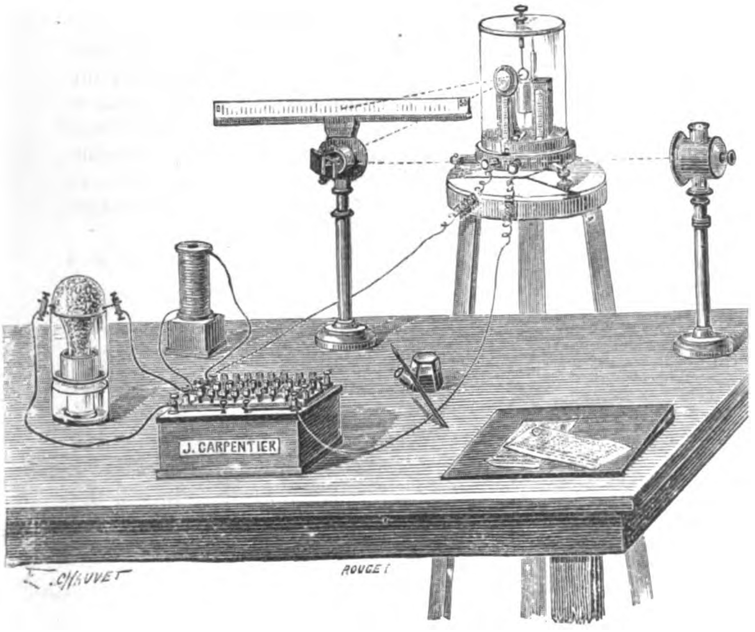

FIGURE 2.

sees a bright patch about 1 inch square having a single sharply defined black line—the image of the aforesaid wire—down its middle. This patch of light and the central line are perfectly visible in broad daylight, but cannot be well seen by more than one observer at one time. The adjustment of the lamp and scale is a simple matter; and light from any lamp in the room—an overhead gas-light for example—may be used instead by turning the adjustable mirror to the proper angle.

When set up without any shunt, this galvanometer will show a deflection of 1 millimetre on the scale for about 1.100,000,000 of an ampère of current; but the sensitiveness differs in different instruments with the construction of the coil, the stiffness of the suspension, and the power of the magnets. Two instances of its application may be given.

The instrument can be applied as a volt-meter to measure the electromotive forces of cells. An ordinary reversing key is connected to the galvanometer, and an adjustable resistance (a Wheatstone rheostat with a thin wire having a range from 1 to 200 ohms is convenient) is interposed as a shunt, across the terminals of the galvanometer. To calibrate the instrument a standard Daniell cell (E.M.F. =1.07 volt) is placed in circuit with a resistance box, the reversing key being placed between the battery and the galvanometer. A resistance of 10,000 ohms is unplugged and a reading is taken of the galvanometer, first to left, then to right, and the shunt-resistance is then adjusted until the scale reading is 53½ millimetres on either side of zero, making a total of 107 millimetres. We then know that a deflection of 1 millimetre right or left will be produced by an electromotive force of 1.200 of a volt. The cell whose electromotive force is to be tested is then substituted at B in place of the standard cell, and readings taken right and left; these are added, and divided by 100, giving the E.M.F. of the cell directly in volts.

To measure currents the same calibration is made with a standard cell. In the circuit of the current to be measured is interposed a wire of some small but accurately known resistance—for example, a standard 1 ohm, or, for stronger currents, a standard wire of 0.1 ohm. The two extremities of this coil are then connected to the key, the 10,000-ohm coil being interposed as before. If the current to be measured is 1 ampère, it will, in passing through the standard 1 ohm, produce between its ends a difference of potential of 1 volt, and this difference of potential will, when readings are taken right and left, give a total deflection of 100 millimetres to correspond to 1 ampère of current. It is not difficult to modify the arrangements so that the galvanometer may measure, on the one hand, millionths of an ampère, and thousands of ampères on the other. We have found the instrument specially valuable for indicating rapid fluctuations of current in experiments on the induction of currents in armature coils when moved in a magnetic field. Its complete aperiodicity and the very small inertia, both mechanical and electrical, of its coil, render it most valuable for such work. The only defect—and that not a serious one—observed in three months of use, is a slight sub-permanent torsion on the suspending wires after taking a large deflection; but the method of taking double readings, first to right, then to left, eliminates any error that might arise from this cause.

THE DANGERS OF INCANDESCENT ELECTRIC LIGHTING.[1]

BY C. C. HASKINS.

THE decision of the insurance companies of New York, no less than the municipal ordinances of several other cities concerning the installation of electric light wires of the several incandescent systems, requires the placing of the positive and negative wires a specified distance asunder, to the end of avoiding the possible establishment of arcs between them and the prevention of damage resulting therefrom. It is perhaps needless to say that lamps of this order are usually placed in derivation, which requires the wires to be in relatively close proximity to each other, and it is usual to place them in mouldings of wood, thus concealing the otherwise unsightly conductors. As a sequel to a friendly discussion as to the best way of disposing of such wires, relative to safety I made, in connection with Mr. Charles Wirt of the Western Edison Light Co., of Chicago, the following experiments:

1. The wire employed was No. 14 B.W.G. of copper, covered with two layers of cotton wrapping, and coated with an incombustible paint. This insulation is very good when dry, but its hygroscopic capacity renders it very susceptible to moisture, which of course much reduces its insulating properties. This wire was connected in derivation as shown.

IN the figure *a* represents a wire No. 14 B.W.G; B B B are Edison incandescent lamps of 16 candle power; C C are fusible strips of the usual form. The wires were placed upon a dry pine board and bound together by means of thread, when they were liberally wetted with hydrant water. For some time no visible effect was manifested, but shortly

1. *La Lumière Electrique*, Sep. 20, 1884.

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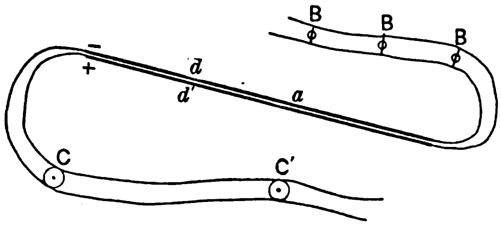
afterward a violent ebullition was observed through about an inch of contact, accompanied by very considerable heat.

Placing the dampened fingers upon the two wires quite severe shocks were experienced through their insulation, which was greatly magnified by making contact with the naked coupling of one wire, while the other hand remained upon the insulation of the other. The current with which we were experimenting had an intensity of about 0.9 ampères, the E.M.F. 110 V, and the lamps showed no per-



ceptible diminution of light. At the end of 12 minutes we opened the insulating substance on the opposite surfaces of the wires at *dd*, about 18.5 mm (.7 inches), and at the end of 5 seconds an arc was formed, and the strip C melted, extinguishing the lights.

2. Two strips of brass 125 mm (5 inches) long by 12.5 mm (0.5 inches) wide and 1.25 mm(.05 inches) thick, were substituted for the wires (these having soldered connections), firmly fixed by clamping to a dry pine board, separated laterally 77.5 mm (3.1 inches). To hasten the action of the current a solution of caustic potash was substituted for water. Ebullition was exhibited immediately, and evaporation was quite rapid. At the expiration of 8 to 9 minutes a stick of the potash was placed between the plates, but without touching either. The potash was almost immediately reduced, and the electrolytic action resulted in giving us a fine exhibit of burning potassium. Despite the drenched condition of the board it commenced to burn, and the heat developed melted the soldered connections. In 5 seconds the arc was formed and the safety strip C exploded

3. The same experiment was repeated, the action being hastened by the soaked condition of the board, the strip melting in 30 seconds.

4. Changing the plates to a dry portion of the board 6 lamps were placed in circuit at B B B, and a 9 lamp safety strip at C and C'. Two minutes only elapsed before both of these succumbed together.

5. Three lamps with a 3 light strip. Immediate melting of the strip.

6. Six lamps with a 6 lamp strip, the plates having been placed anew, and separated 37.5 mm (1.5 inches), Melting occurred in 2¼ minutes.

7. With the plates 18.5 mm (0.7 inches) apart, and 3 lights with a 3 light safety strip, the destruction of the strip was instantaneous.

8. Six lights and 6 light strip. Time 15 seconds.

9. Plates separated 10 mm (0.4 inches), 3 lamps and 3 lamp strip. Time 10 seconds.

10. Plates unchanged; 6 lamps, 6 lamp strip—5 seconds.

11. Plates 4.5 mm (0.18 inch) asunder, 3 lamps and 3 lamp strip. Time 5 seconds. In this experiment the plates were blistered by the heat.

12 and 13. Plates remaining in the same position; 6 lamps and 6 lamp strip. Fusion instantaneous.

14. Plates the same. With 6 lamps and a 9 lamp strip, 3 seconds sufficed to explode the strip.

The natural conclusion to be drawn from these results seems to me to be that the wide separating distance between + and — wires ordered by the authorities, becomes an element of danger rather than a means of protection.

It seems certain that the slower the carbonization of any combustible with which wires are in contact the more positive will be combustion when the arc is once formed, while on the contrary if the arc is formed suddenly the inflammable material will not so readily take fire, not having been exposed to the slow carbonizing process, and the danger is consequently lessened.

From this reasoning it would seem eminently safer to place properly insulated wires as near as possible to each other in installing incandescent plants.

ON A METHOD OF MEASURING SMALL RESISTANCES.[1]

BY F. UPPENBORN.

In the measurement of very small resistances other organizations must be substituted for the Wheatstone bridge, and recourse had to different methods. As the resistances to be measured become less, the resistance of the contacts introduce a constantly increasing error. Hence it becomes necessary to employ methods by which resistances of very different magnitudes may be compared independently of the resistance of the contacts.

The Wheatstone bridge is a method in which we project electrically, as it were, upon a conductor, the unknown resistance and a comparative known resistance, which conductor is by this projection divided into two parts, the respective resistances or lengths of which may be easily found. It is therefore plain that if the resistances of the contacts are great in comparison with the actual resistances, their projection if enlarged in the same proportion will sensibly affect the accuracy of the measurements. Bearing this in mind it is easy to introduce into the bridge a modification which will ensure the accuracy of the results.

This modification, generally known as Hockin's and Matthiessen's method, is represented in figure 1 :

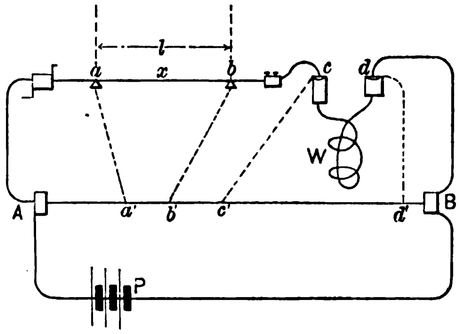


FIGURE 1.

A wire of nickel-silver, of 2 or 3mm. in diameter, and of 1 or 2m. in length, is stretched between the two clamps A and B. From these clamps proceeds a circuit containing the unknown resistance x, and a known resistance W, for which the normal unit may be chosen. To effect the electric projection in question, we establish a difference of potential between the points A and B by connecting the respective clamps with the poles of a group of elements P. We then find by trial a point in the wire A B having the same potential as the clamp or mercury cup d, to which is attached the resistance W which we assume as the standard resistance. To this end we make use of a very sensitive galvanometer, for example the aperiodic galvanometer of Thomson, Siemens, or D'Arsonval. We connect one of the terminals of the galvanometer with the mercury cup d, and the other with a contact which slides along the wire A B, and which is moved until a point, d' is found at which the galvanometer shows no deflection. The point d' is then the required projection of the point d. By the same method we project c and determine c'. If the resistance to be measured is a wire of which the specific resistance has to be found, it is well not to project the entire length of the wire upon the bridge-wire A B but to operate merely upon

1. *La Lumiere Electrique*, xiv., p. 336.

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its middle portion l, the resistance of which will not be affected by the manipulations which have to be carried on to establish the communication with the terminals. By projecting the two points a b of the length l upon the bridge-wire A B we obtain the points a' and b'. The unknown resistance x of the length l is then $x = \frac{a'\,b'}{c'\,d'} W.$

This equation, however, is based on the supposition that the wire A B is homogeneous; that is to say, that any two sections of the wire of equal length offer the same resistance. To check the accuracy of this assumption we have recourse to the method of Messrs. Strouhal and Barus, which is merely the method of electric projection just explained.

For the derived circuit containing the two resistances to be compared, we substitute a series of nearly equal resistances as shown in figure 2, which are formed of 3 or 4 turns

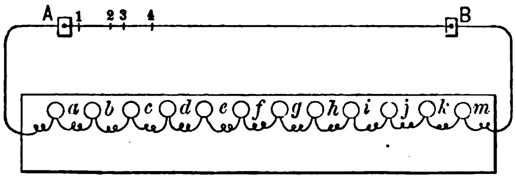

FIGURE 2.

of a wire of nickel-silver 2mm. in diameter coiled upon bobbins of dry wood. Each resistance has heavy copper terminals. The resistances are arranged upon a board, which supports a series of mercury cups. As soon as the points A and B have been connected to the battery, we project the first resistance, a b, upon the conductor A B, and obtain the points 1 and 2, which have the same potential. It is evident that this projection is wholly independent of the absolute strength of the current, which merely affects the numerical value of the potentials, not the situation of the points which we may call isopotentials.

We measure then the length of the portion 1 to 2 by a scale with the necessary precautions. We then move the resistances, a b b c, and make a new projection, which gives the length 3 to 4. We thus make a series of projections, increasing step by step the resistance, which at the outset was in front of the points a b. By this method we obtain a great number of projections of the same resistance upon different portions of the wire, A, B, which is to be calibrated. If this wire is homogeneous throughout its entire extent, the lengths as successively measured will be equal, that is to say we have 1 to 2—3 to 4—5 to 6, &c. If on the contrary, these quantities are sensibly different, it is necessary to calibrate the wire A B by means of emery paper. For this purpose we construct a table showing the several lengths projected, as well as their differences from the shortest length, which corresponds evidently to the least cross-section of the wire.

We have for example:

Place of Resistance No. 1.	Length.	Difference.
No. 1	101.3 ...	... 1.8
2	102.1 ...	... 2.6
3	103.0 ...	... 3.5
4	102.5 ...	... 3.0
5	101.2 ...	... 1.7
6	100.0 ...	... 1.3
7	100.2 ...	... 0.7
8	99.5 ...	... 0.0
9	99.7 ...	... 0.2
10	101.2 ...	... 0.7
11	100.5 ...	... 1.0
12	100.7 ...	... 1.2

We rub the wire with emery paper (excepting of course the thinnest portion, 99.5), the energy of the friction being proportional to the differences shown in the above table. When this operation is completed, we repeat the measurements already described, and so on until the calibration of the wire is perfect.

By employing a stretched wire of 1 or 2 metres we may compare resistances which have among themselves the proportion of 1-10, and that with an error less than 0.5 per cent. With a normal standard it is easy to form 10 standards, each of 0.1 ohm, which when connected in multiple arc, enable us to construct 0.001 ohm. With this latter standard we are then able to measure resistances of 0.0001 ohm, with an accuracy of 0.0000005 ohm.

We have made use of the method of Hockin and Mathiessen for determining of the conductivity of different copper wires employing a normal Siemens unit in the form of a box. In making determinations of this kind, the section of the wire of which the conductivity is to be ascertained is computed[2] from the length and weight. These two last measures, considering the perfection of the processes and apparatus now at the command of physicists, may be ascertained with great accuracy. We have thought it interesting to describe this process in a slightly modified form, which shows well the general applicability of the method.

The method of the electric projection of resistances presents incontestable advantages, and may be applied in many of the cases which electricians meet with in practice. Its only defect is the multiplicity of measurements, it being necessary to to go through four different operations with the galvanometer, in order to find the relation of the 2 resistances.

[Referring to the above article, Herbert Taylor, in a letter to the London *Electrical Review*, says that the method is of especial value in determining the temperature produced in a wire by the passage of a given current. "In the ordinary method, when the extremities of the wire experimented on are attached to massive copper terminals, at the temperature of the air, a correction for loss of heat by conduction is necessary, which correction Sir William Thomson has furnished in a note appended to a recent paper by Mr. Bottomley on this subject. This correction is somewhat complex, and may be entirely avoided by the method which Mr. Uppenborn has noticed, in which the galvanometer contacts can be shifted towards the centre of the wire."

"For the last three years I have used this method, and during that time, having taken many thousands of observations, I can speak from experience as to its utility and great convenience."

"Mr. Uppenborn refers also to a system of calibration which he attributes to Messrs. Strouhal and Barus. I do not know the date of their paper on the subject, but it was devised independently by myself in 1881, and is fully explained in a paper of that date communicated to the British Association."

"The mode proposed by Mr. Uppenborn of correcting the inequalities in the wire by the use of emery paper, is, in my opinion, very objectionable and quite unnecessary. A german-silver wire is easily procured, in which the resistance is nearly uniform, and if this is found not to be the case in a particular wire, it is better to discard it and try another sample."

"With all precautions, however, some want of absolute uniformity is sure to be found; and it is best to calibrate in the manner referred to, and prepare a table showing the necessary correction to be made on any observed reading."

"I also consider the length of wire [1-2 metres] suggested by Mr. Uppenborn insufficient to obtain the full advantage of this system of testing. The wire I employ is of platinum-iridium, 12m. long, 1.75mm. in diameter, and is wound on a drum in twenty convolutions; this wire has many advantages over German silver, being harder and not liable to injury from acid or mercury; its only drawback is its high cost, about 50s. per ounce."]

2. Maxwell's Electricity and Magnetism, I., 406.

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THE AMET AUTOMATIC ELECTRIC GOVERNOR.

The value of electricity as a controlling agency by which a prime motor may be promptly and efficiently regulated has long been recognized. It has been utilized for this purpose in various devices. The most successful printing telegraph instruments are driven by the accumulated power of springs, weights, or steam, the mechanism being under electrical control. Now that electric lighting has brought steam and water power into closer relations with electrical machinery, the question of instantaneous adjustment of the power to the load has become of the first importance, and this result appears to have been practically attained in the electric steam and water governor invented by Edward H. Amet. The necessity of such a governor was fully appreciated by the pioneers in the electric lighting business, and became more and more apparent as circuits were extended and it was found that lamps must be cut in and out of circuit, at a distance from the generating station.

The mechanism of this apparatus is simple, substantial and effective, and will be readily understood by referring to figure 1.

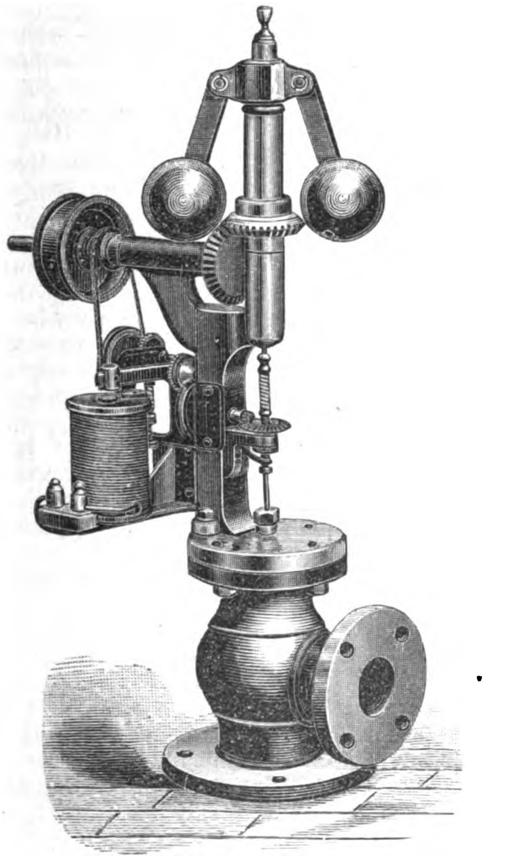

Figure 1.

A small train of gears is belted to the governor shaft, and is connected by means of friction wheels to a beveled gear, which actuates the steam valve by means of a screw thread on its stem. The contact between the friction wheels is graduated by the varying strength of the electro magnet, which is embraced in the lamp circuit. It is obvious that as the resistance of a circuit is decreased by the cutting out of lamps, the increased attraction of the magnet acting through its armature upon the friction gearing as shown, will at once shut off a sufficient quantity of steam to decrease the speed and generating capacity of the dynamo, and at once restore the normal condition of current required to operate the lamps remaining in operation.

A practical test of its efficiency was recently made at Carnegie's rolling mills in Pittsburg under rather unfavorable circumstances, but the apparatus proved equal to the task imposed upon it. The details of this trial are thus given by the *American Manufacturer:*

"The steam driving the Westinghouse engine furnishing the power for the electric lights in the above test was taken from a large pipe which was supplying one of the large engines running a train of rolls in the mill, and whenever the latter engine required an increased amount of steam the pressure was considerably reduced on the Westinghouse, thus giving the new governor a much larger range of duty to perform than is ordinarily required of any governor.

"In the test, at first 4 lights were cut out of the circuit, thus decreasing its resistance and increasing the strength of the current, which, by means of the magnet on the governor, brought into play one of the friction wheels and lengthened the valve stem on the governor, reducing the speed of the engine and dynamo to that required to furnish the number of lights in the circuit. Next, 13 more lights were cut out of the circuit, to which the governor as promptly responded, and when all the lights were thrown out of circuit the engine was just kept in motion, but ready to furnish power when required."

In adapting the governor to the control of water power a different arrangement is required, which is shown in figure 2.

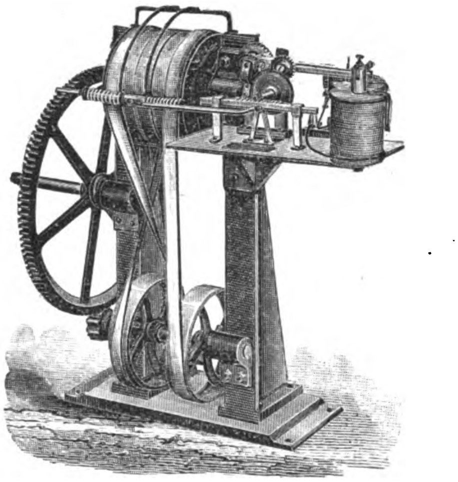

Figure 2.

In this case the gate is raised or lowered by means of the gears at the left, driven by belts leading from the pulleys attached to a running shaft which is omitted in the engraving. One of these belts is crossed, so that motion may be given in either direction. The belts are shifted from the loose to the tight pulleys or *vice versa*, by the operation of a pinion and rack, the pinion being thrown into action by the friction pulley as the electro magnet becomes vitalized, in the same manner shown in the description of the steam governor. Among the practical advantages claimed for this governor are the following: 1. It economizes power. 2. It keeps the lights at a normal brilliancy. 3. It saves the armature, and prevents fires arising from overcharged wires. 4. It maintains a uniform current. 5. It is not liable to get out of adjustment. 6. It does not burn out. 7. It will save its cost every year.

THE COMPOUND DYNAMO.

A recent number of the *Zeitschrift für Elektrotechnik*, contains an article on the use of compound dynamos for maintaining a self-regulating system of incandescent lamps. The author of the article maintains that the difference of potential at the terminals of a compound machine does not remain sufficiently constant to enable a regulator to be dispensed with. The article goes on to say that an installa-

tion of incandescent lamps cannot be considered satisfactory unless the life of the lamps averages at least 800 or 1,000 hours. To obtain this result, however, no individual lamp must be subjected to variations exceeding 1 per cent. of its normal potential. It is manifest that this degree of constancy cannot be brought about except by means of a regulator, even in the case of a compound dynamo, for if the strength of the current varies 20 per cent., the difference of potential at the poles of the machine will vary about 3 per cent. A good shunt dynamo (such, for instance, as Edison's) gives results almost as satisfactory, for an increase of 10 per cent. in the current only increases the difference of potential at the terminals by 1 per cent., while 25 per cent. increase of current only gives an increase in potential of about 4 per cent. But there are other causes of irregularity still more unfavorable to the maintenance of a constant difference of potential at the terminals. The variations in speed of the engine are seldom less than 5 per cent., and these of course cause similar variations in the difference of potential at the terminals. It is scarcely possible to install a plant so carefully that from a mechanical point of view the driver can ensure absolute uniformity in speed without a governor. The loss of potential in the conductors is another source of variation at the terminals. A plant may, in fact, be considered to be put down under exceptionally favorable conditions if the loss from this cause alone does not exceed 10 per cent.; say, 8 per cent. for the mains and 2 per cent. for the lamp branches. If then, a group of lamps be switched off, and the volume of current reduced one-half, the resistance of the main conductor is just so much reduced (?) and the lamps which remain in incandescence work under an increased potential of 4 per cent. There is a still further cause of inconstancy, viz.: the heating of the dynamos. If the internal resistance of a machine be increased in consequence of the heating of the armature wires, it necessarily modifies the difference of potential, a source of variation for which the combination of the best designed compound winding can offer no remedy. In fact, in all installations in which compound dynamos are employed it is always found necessary sooner or later to add a regulator. But if a regulator be required, as in the case of a simple dynamo, of what advantage is the compounding ? It is certain that the useful effect is not greater, for at recent exhibitions the shunt-dynamos have given the highest percentage of useful effect. On the other hand, compound dynamos have at least one incontestable disadvantage, which is, that on short circuit the conductor of the induced current is often burned in spite the best cut-outs, while with the shunt-dynamos under the same conditions only a lessening of the volume of current takes place.

With reference to the above arguments against compound dynamos, Fr. Uppenborn says that they are only apparently true. "It is neither necessary nor possible" he contends, "to attain constancy within 1 per cent. In practice, incandescent lamps constructed for a difference of potential of 100 volts exhibit a difference of 5 per cent in the potential required to raise them to the same temperature. The manufacture has not yet attained such perfection that a greater degree of precision may be relied upon. The manufacturer does not employ such accurate measuring instruments as the engineer charged with the installation, and differences of 4 or 5 per cent, are allowable. Nor is it true that a compound dynamo for an increase of 20 per cent. in current manifests a difference of potential of 3 per cent. A Schuckert machine only shows a variation of 3 per cent., in a current varying from zero to maximum. If this result cannot always be reached it is at least possible to closely approach it. The heating of the machine is not of great importance. For example a compound dynamo of which the armature offers a resistance of 0.31 ohm to 28 ampères; the resistance of copper increases 0.4 per cent. for every degree centigrade. Suppose a variation of temperature of 20° C., which corresponds with an increased resistance of 8 per cent., or 0.025 ohm. The product of the maximum current 28 ampères by 0.25 ohm, gives 0.7 volt. The field magnets are also constructed of low resistance so that the tendency to heat is inconsiderable. A shunt dynamo, other things being equal, is less constant than a compound ; and the statement that the difference of potential at the terminals of an Edison dynamo is only 1 per cent. for 50 per cent increase in current must be taken *cum grano salis*. But assuming this to be strictly true, it only proves that the dimensions of an Edison machine are quite abnormal. The field magnets are excessively large in proportion to the armatures, especially in the original American type. The machines which gave the diagrams referred to are, on the other hand, of nearly the same dimensions, and it is rational to compare them. Now, in this case, the maximum product of the current into the difference of potential at the terminals is obtained, when R=26 ohms, and from 30 to 40 ohms the difference increases about 25 per cent. This shows conclusively that it is more advantageous to construct a compound dynamo with an equal quantity of copper, because however unfavorable the conditions under which such a machine may be installed, it will never show a difference of 20 per cent."

In a recently published letter to the London *Electrician*, Mr. W. Macgregor controverts a statement which recently appeared in that journal to the effect that the first dynamo machines made practically self-regulating by the compound principle, were made and set at work by Messrs. Crompton for Mr. Coope at Berechurch Hall, near Colchester, in the spring of 1882, and asserts that the first dynamo applied practically to work on the compound-wound principle was by Dr. Paget Higgs, at Greenpoint, Long Island, in 1881. This application was made to a Wood dynamo constructed by the Fuller company, and was carried out under the instructions of Dr. Higgs himself, the series coils on one side of the machine being replaced by fine wire shunt coils. It was subsequently removed to Philadelphia, and was there publicly exhibited. The machine was driven by a Colt's 6 h. p. disc engine, running at 900 revolutions, steam being supplied by a 10 h. p. Baxter boiler. Maxim's incandescent lamps were used. Moreover, the machine had been previously seen by Professor Trowbridge, of Harvard College, to whom the compound principle of winding was explained by Dr. Higgs.

Four Gramme machines were compound-wound under Dr. Higgs's instructions as early as April, 1881, at New York, which are still at work. In November, 1881, Dr. Higgs shipped to Liverpool two compound machines wholly made by him, and one of which is still in good working order. In fact, as early as May, 1880, according to Mr. Macgregor, Dr. Higgs was constructing self-regulating machines of an experimental character in Boston, and his first application for letters patent was dated April 22, 1880. He obtained a patent on June 7, 1881, No. 242,644.

The original and first inventor of what is now known as the compound-wound dynamo, appears to have been Charles F. Brush, who fully described and claimed it in an application for U. S. letters patent filed March 11, 1878, and issued July 22, 1879, No. 217,677.

The application of it to the purpose of regulating an electric light system is not, however, suggested in this patent. It would seem that Dr. Higgs was the first to practically apply the compound-winding to this particular purpose. Edison patented on September 19, 1882, two or three plans of incandescent lighting in which the general principle is indicated, though it does not appear that he had ever practically applied it. His plans, moreover, are materially different in detail from the actual one now used, the origin of which has been the source of so much discussion in the technical journals. The series of patents, thirty-one in number, issued to Mr. Edison on the above date, contain many interesting features.

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DOLBEAR'S TELEPHONIC RESEARCHES.[1]

BY PROFESSOR EDWIN J. HOUSTON.

As we have already intimated, Professor A. E. Dolbear, besides inventing the new system of electro-static telephony, has done much to give the present system of magneto-electric telephony its present commercial efficiency. His inventions in this direction cover a wide and varied field of research. We will describe some of the more interesting and valuable of these inventions.

It would appear that Dolbear was the inventor of the magneto-electric telephone. He was the first to point out the fact that the ordinary electro-magnets employed in the articulating telephone could be dispensed with, and permanent magnets used in their stead. He invented the magneto-electric telephone in September, 1876, and constructed his first magneto-electric telephone as early as October of the same year.

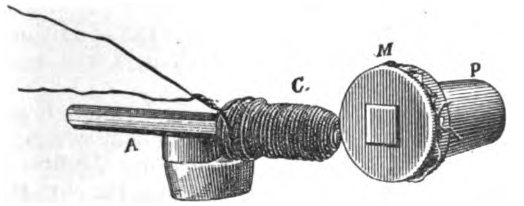

FIGURE 1.—Dolbear's Original Magneto-Electric Telephone.

In figure 1 is shown the original Dolbear magneto-electric telephone from a photograph of the identical apparatus. As will be seen, it was somewhat crude in construction but was fairly efficient in operation and contained all the essentials of the magneto-electric instrument.

A permanent bar magnet, A, had a coil of insulated wire C, wound around one end only. Its armature was formed of a rectangular piece of sheet iron fastened to the middle of a thin rubber diaphragm, that was firmly stretched on the end of one of the hard rubber tubes of an old opera glass. This form of apparatus was designed for use both as a transmitter and as a receiver, and was employed without a voltaic battery.

Crude as this instrument was, its invention marked a great advance in the art of telephony. Like many things that appear of the greatest simplicity when once originated, its successful operation could hardly have been confidently predicted. Indeed, we doubt whether most electricians would have believed that the magneto-electric currents thus generated by the voice would possess the requisite strength to reproduce the voice. It would scarcely have been considered probable that the resulting magnetic variations in the receiving instrument could produce such movements in the diaphragm as would permit it to reproduce audible, articulate speech. The scientific world was then, to a great extent, ignorant of the exceedingly small amount of motion

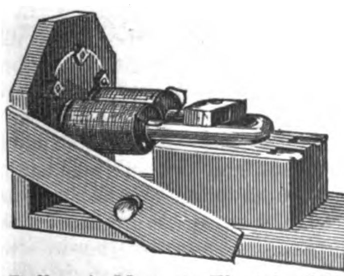

FIGURE 2.—Dolbear's Magneto-Electric Telephone (Bi-polar).

requisite to produce audible sounds. It also lost sight of the very evident fact, that the comparatively great velocity of movement of the magnetic diaphragm, must necessarily result in the production of a proportionately large current in the coils of wire on the magnet pole.

Dolbear improved the magneto-electric telephone shown in figure 1, by an instrument that he constructed in December, 1876. This form of instrument is shown in figure 2, and consists of a horseshoe magnet of round steel, that is, of course, permanently magnetized. Bobbins of insulated wire are placed on the ends of the poles in the position shown. Figure 2 is reproduced from a photograph of the instrument as actually made by Prof. Dolbear. It is interesting as showing a metallic diaphragm, bolted at its edges to the upright, wooden mouth-piece. The bobbins on this instrument were taken from an old telegraphic instrument. Dolbear employed his first metallic diaphragm in October, 1876, in an instrument used in connection with the apparatus shown in figure 1. His first metallic diaphragm consisted of a piece of sheet iron that entirely covered the end of a wooden tube.

In figure 3 is shown an ingenious form of transmitter invented by Dolbear in 1878, and named by him the finger transmitter. It consists of an empty tomato-can, the metallic bottom of which is brought into good electrical contact with one end of an electric circuit by wrapping the wire around the bottom edge and soldering it thereto. If now the wire from the other terminal of the battery circuit be grasped in the hand, and the finger be held against the middle of the bottom of the can, as shown, any sound made into the open end of the can will vibrate its bottom and thus vary the strength of the battery circuit, by reason of the varying contact of the finger and the bottom of the can. If, therefore, any form of receiving instrument be introduced into the circuit, anything spoken into the open end will be distinctly heard in the receiving instrument.

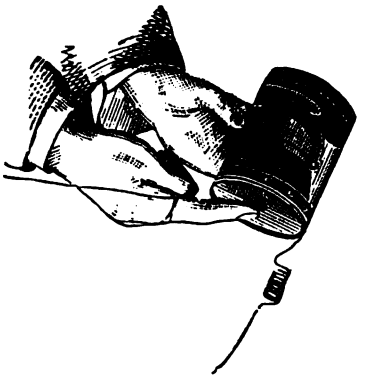

FIGURE 3.—Dolbear's Finger Transmitter.

Since the resistance of the finger is high, it is necessary to employ from 10 to 20 gravity cells in order to obtain satisfactory results.

This form of transmitter is dependent for its operation on the principle of the microphone transmitter, or in other words, it is a variable resistance transmitter. Though of comparatively little practical importance, it is interesting as illustrating the ease with which efficient telephone transmitters may be constructed; or how readily one could be devised for use in case of a sudden emergency.

In a previous article we spoke of Dolbear employing for a transmitting instrument a modified form of Reis transmitter. In figure 4, is shown a back view of one of these modified transmitters. A brass tongue, the end of which is tipped with a platinum wire is fastened to the inside of a wooden ring, so that the end of the platinum tip touches the middle of a vibrating diaphragm. The screw that may be seen passing through the cross bar, serves to regulate the pressure of the platinum tip upon the plate. The brass tongue has one of the terminals of a battery connected with it, and the metallic plate or diaphragm is connected with the other terminal. These wires are shown in the figure as passing through the handle.

1. *The Journal of the Franklin Institute.*

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This transmitter, which, it will be observed, differs from the forms employed by Reis, mainly in the fact that the ordinary membraneous diaphragm is replaced by a metallic diaphragm, has been successfully employed by Prof. Dolbear to transmit intelligible, articulate speech between Boston and New York. When used for this purpose it was included in the circuit of 100 gravity battery cells, and the speech reproduced by the receiving instrument was

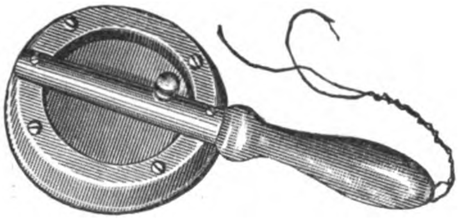

Figure 4.—Dolbear's Modified Reis Transmitter.

so loud and distinct, that it was heard at a distance of 10 feet from the receiver.

This transmitter is especially effective when included in the primary circuit of an induction coil. Without stopping here to discuss the peculiar advantages of the induction coil in telephony, it may be well to remark that the currents sent over the main line from the secondary coil are of the alternating character that characterize the magneto-electric currents.

Besides the modified Reis transmitter shown in connection with figure 4, Prof. Dolbear has invented a number of multiple transmitters ; one of these is shown in figure 5.

In this form of transmitter 4 separate terminals are shown, so arranged that all of them may be placed in the same circuit, or each may have a separate circuit of its own, and thus be employed with 1 induction coil, like a single terminal one, "or with multiple points, each with its own circuit in an induction coil with multiple primaries, or with separate coils, or any combinations of these." In this form of transmitting instrument, Dolbear has arranged the vibrating plate horizontally as in Reis's second form of transmitter.

Dolbear has invented a quite distinct genus of telephone receivers to which he has given the general name of rotophones. This instrument, like Edison's motograph, operates by variations in friction. It is quite distinct, however, in the method of its operation, an electric current being caused to modify the magnetic friction of a body attached to the centre of an elastic diaphragm.

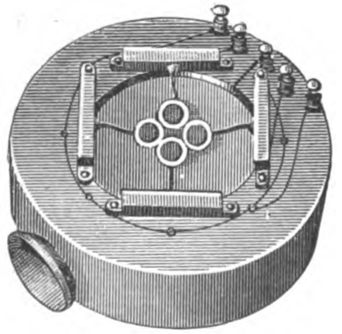

Figure 5.—Dolbear's Multiple Transmitter.

In Edison's motograph, a diaphragm is set into vibration by the variations in the friction of a metal strip on a cylinder of chalk. The chalk cylinder is saturated with an electrolyzable substance and is rotated. The passage of an electric current between the metal and the chalk will cause the friction between these 2 surfaces to become less. If, therefore, the cylinder be rotated the friction will vary with variations in the current, and corresponding movements will be produced in a diaphragm that is connected with the metallic strip.

Now Prof. Dolbear employing these variations in magnetic friction has constructed a distinct genus of re-

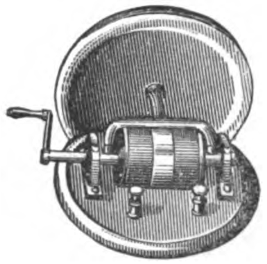

Figure 6.—Dolbear's Rotophone.

ceiving telephone, the principles of operation of which will be understood by reference to figure 6. An electro-magnet, with a straight core, is provided with a handle so that the core can be readily rotated. A flat **U**-shaped armature is provided, the ends of which are permitted to rest on the ends of the core that project beyond the coil. In the middle of the **U**-shaped armature a short rod is secured at one end, the other end of which is attached to the centre of a vibrating plate of mica, or elastic metal. The explanation of its action is thus stated by Prof. Dolbear in a paper descriptive of the rotophone, that he read before the American Academy, on May 14, 1879. "When a current of electricity is made to traverse the coil, the core becomes a magnet and the armature is attracted to it ; if the core be rotated, the adhesion of the armature will carry the middle of the diaphragm towards the magnet, and if the current be stopped, the elasticity of the plate will cause it to return to its original place. A vibrating current will thus set up corresponding vibrations in the diaphragm so long as the magnet turns."

Prof. Dolbear has produced some very simple and curious modifications of this form of telephone receiver. For example, if the end of the string of a common string telephone be tied to a nail, and the latter be placed on the pole of an electro-magnet that is in the circuit of a transmitting instrument, a person listening at the tube of the string telephone, will distinctly hear whatever is uttered into the transmitter, provided the nail is slowly drawn over the magnet pole. A motion of but two inches a minute will be sufficient in most cases.

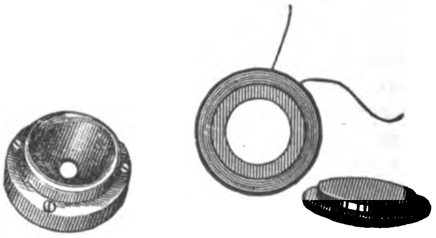

Figure 7.—Early Forms of Dolbear's Static Telephones.

In figure 7, 2 of the early forms of Dolbear's static telephones are shown. One of these consists of 2 tin discs about 2 inches in diameter, separated from each other by a rubber ring about a quarter of an inch in breadth, thus forming a true air condenser. These were mounted in wooden cases, with an opening through the face for listening.

The form of static telephone shown in figure 7, to the right, consists of a circular plate of tin securely fastened to the bottom of a shallow box. Electric conduction, between the back and front disc is prevented by the use of a ring of paraffined paper. The front disc was formed of a disc of gilt paper, tightly stretched over a ring and connected to one of the terminals of an induction coil.

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The 2 forms above described in connection with figure 7, were but a few of the numerous evident modifications of the same that were tried. Dolbear also made a telephone receiver, of a series of condensing discs. In one instance as many as 50 of these separate discs were used. As might have been expected, however, this modification was not productive of any good results.

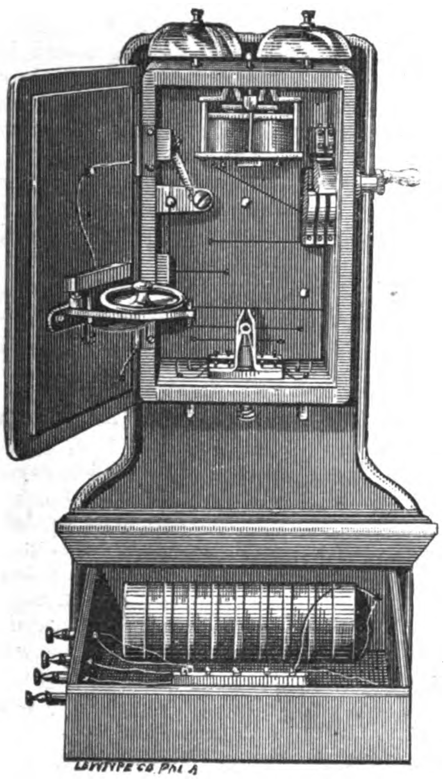

FIGURE 8.—Dolbear's Secondary Ringers.

The resistance of Dolbear's receivers is of course very great. One of them, he states, has a resistance of upwards of 10,000 megohms, while its capacity is about 2 or 3 ten-thousandths of a microfarad.

In figure 8 is shown Dolbear's arrangements for call bell, transmitter, etc. The handle, shown near the upper right corner of the figure, when turned rapidly makes and breaks the circuit of a number of battery cells that are placed in the lower part of the box. In this circuit is included the primary wire of an induction coil, seen in the lower part of the figure. The ends of the secondary coil are connected to the main line, and the currents produced therein by induction, consequent on the making and breaking of the primary circuit, traverse the main circuit and ring the bell at the distant end of the line. By means of this exceedingly efficient form of apparatus, call bells are readily rung at distances of over 1,000 miles.

The ends of the secondary coil being connected with the main line the electrical charges are of course sent into the plates of the receiving instrument that is placed in a branch circuit between the terminals of the induction coil.

The ringing of the bell, therefore, at the same time charges the receiving instrument and thereby sensitizes it to its maximum, thus fitting it to act as a delicate receiver when removed from its hook.

The transmitting instrument is attached to the door of the box and is then enclosed when the door is shut. It consists of a shallow box with a modified Reis transmitter in which the platinum points ordinarily employed by Reis are replaced by carbon tips.

CENTRAL HIGH SCHOOL,
PHILADELPHIA, November 25, 1884.

THE BALL UNIPOLAR INDUCTOR DYNAMO.

BY CHARLES WARD RAYMOND, C. E.[1]

(Member N. Y. Electrical Society ; Jun. Member Am. Society C. E.)

I WISH to preface my remarks by saying, I was connected with the Ball Electric Co. for two years, but am not now, and have not been for the past six months.

I shall give in this paper a description of, and a few facts concerning a dynamo machine, about which many remarks for and against have been made, leaving to my hearers to apply any and all theories as to why the machine works, asking them only not to waste their time in trying to find out why it ought not work, assuring them it is a fact it does work, and works well, the opinions of several learned and well-known electricians to the contrary notwithstanding.

The Ball "Unipolar" Inductor Dynamo was invented by Charles Eugene Ball, of Philadelphia, in 1881. In 1882 the first machines were constructed in considerable quantities. This was the machine first brought before the public here, and in Canada and England. A brief description of it may not be out of place. It consists of a long rectangular frame of iron, the sides of which are the cores for the field, around which are coiled the insulated copper field wires. The end pieces, to which are bolted the side bars, serve as supports for the bearings through which the shafts rotate. There are two shafts in the same line, having a common centre bearing of gun metal; a small disc of brass is interposed between the ends of the shafts to secure magnetic insulation. On each of these shafts is mounted an armature of the Pacinotti type. The construction of the machine is such that it has the appearance of having four pole pieces, one on each side of each armature, while in reality there are but two, the other two pieces being neutral, or nearly so, having but the slightest magnetism when the machine is in action, the neutral line being a little to one side of the centre of the pole piece. The armatures of this machine rotate in opposite directions, and the whole machine is coupled so that the current passes successively through one armature, one half of the field, the other armature, and lastly through the other half of field. A diagram of the whole (figure 1) is

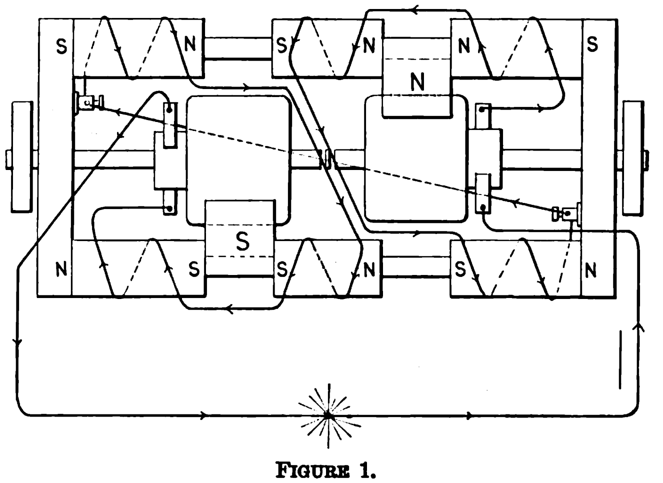

FIGURE 1.

here given. In a report by Mr. Robert Sabine, it is stated, "The effect of this so-called unipolar arrangement, so far as the field is concerned, appears to be that the rectangular soft iron frame is converted into two long electro-magnets, with two poles, only one being presented to each of the rotating bobbins instead of four shorter and proportionately weaker electro-magnets, having four poles, as in the ordinary way, by which two opposite poles would be presented to each of the bobbins."

1 Read by the author before the N Y. Electrical Society, January 14, 1885.

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There were certain advantages in this form of machine which are evident, it being virtually two independent machines in one. But the disadvantage of *requiring* two belts was sufficient to cause the changes adopted in the newer and later form. This machine was tested in several places, but most exhaustively in London, in March, 1883, by Mr. Robert Sabine, whose recent death cast a gloom over the electrical world on the other side of the ocean, and whose memory will ever be cherished by those who love truth for truth's sake; the character of whose work is his greatest monument.

The next form of machine was similar to the above, with the exception that the spaces occupied by the neutral pole pieces were filled up with the field wires. Then followed the present form of dynamo, of which figure 2, is a perspective view. In this the armatures are mounted on one and the same shaft, consequently rotating in the same direction. The field cores are round bars of soft iron, and the field wire is distributed over four bars, two above and two below. The pole pieces, two in number, one above one armature, and one below the other armature, are fastened by bolts to the field bars. The end plates are of soft iron, and to them the round field bars are bolted. This form of machine, while compact, is exposed on all sides, all parts are easy of access, and the whole easily taken apart or put together. The following features strike me as peculiarly favorable in this dynamo.

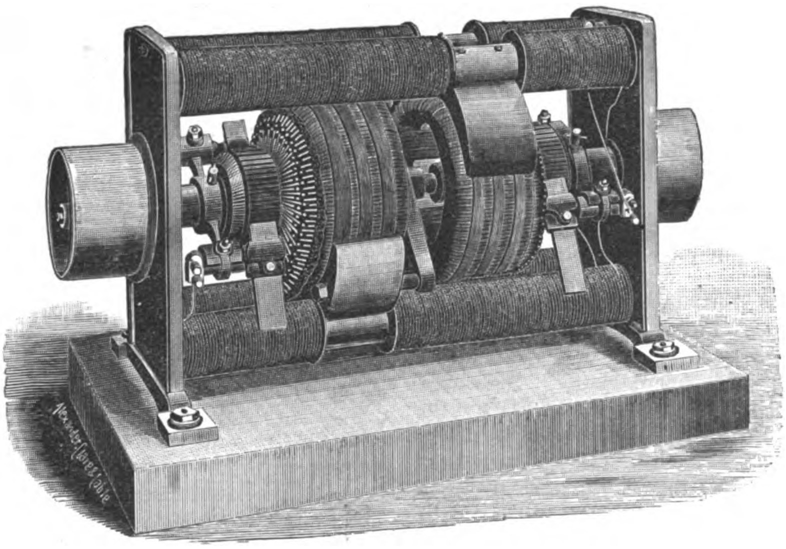

FIGURE 2.—The Ball Unipolar Inductor Dynamo.

By a glance at the construction of the machine the attention will at once be fixed by the comparatively small size of the machine for the results attained, its general compactness, its freedom from complication, or parts more ornamental than useful, and the complete exposure of all vital parts to a good circulation of air.

By compactness is obtained maximum result with minimum space occupied, or minimum size of dynamo, while at the same time every portion of the machine is easy of access.

By simplicity, low cost of manufacture, both in regard to labor and material, is secured. Economical running and freedom from repairs are also accomplished through the lack of any unnecessary mechanism.

In the peculiar arrangement of two armatures or bobbins, each revolving under the influence of but one pole, more is obtained than would at first appear to the casual observer.

It will be seen that on each armature there is a certain amount of copper wire; this amount is much less than is ordinarily wound on a single armature used in a bipolar dynamo of the same capacity; or, in other words, the amount of copper wire on the single armature of a bipolar dynamo is in the "unipolar" distributed over two armatures. This enables two very important results to be obtained; first, the thickness of the section of the armature coils is very much less than in the "bipolar" (about one-third), which, of course, brings the iron core of the bobbin, around which the wire is wound, much nearer the pole-piece; and as the intensity of the magnetism or magnetic effect varies inversely as the square of the distance of this core from the pole-piece the gain in magnetic effect is evident, the nearer the two can be brought together, the greater is this effect. Secondly, by this reduction in the thickness of the covering of the iron core, or the wires wrapped around it, and the greater surface exposed to the air by reason of the two armatures, it is very evident that any heat generated in the core and wires can more easily and rapidly radiate, and the temperature of the armature be kept at a low point. That this is accomplished, is a fact, and the temperature of the "unipolar" armatures is such that it never becomes sufficiently high to char or carbonize the cotton covering of the wires in the armatures.

The form of the field, straight bars of round iron forming part of the frame, is such, that its cost is barely more than the cost of the metal; and as the field wires are wound on the lathe on cylinders of thin metal, it is only necessary to slip them on the bars, make the connections, and the field is complete. This renders repair or change in the field a small item. By the use of wrought or soft iron throughout, the maximum magnetic effect is obtained with a minimum weight of metal. If weight of ironwork be of no importance, the first cost of labor and material can be somewhat reduced by the use of cast iron, but the weight is thereby increased about 25 per cent., with a slight sacrifice of compactness.

Among other good points in mechanical construction may be noticed the long bearings at each end, the gun metal centre bearing supported by the pole-pieces, and a driving pulley on either or both ends. The brushes are arranged so as to be easily removed, or shifted in their holders singly, or as a pair, around the commutators. It will also be noticed that the brushes, of which there are four, are very light and simply constructed, consisting of six or eight strips of very thin (about $\frac{2}{100}$ inch) hard rolled copper, about 6 inches long and $1\frac{1}{2}$ inches wide, simply soldered at one end; inexpensive in first cost, and as they wear very slowly, owing to freedom from sparking, and light pressure, they are a small item in the running expenses. The contact pressure of these brushes is so light as to cause comment; and the little or no sparking enables the commutators to be kept always in excellent condition, with the smallest possible amount of wear.

The method of fastening the wires from the armature to the commutator sections is simple and effective. The wires are easily removed if necessary. The open spaces between the connecting pins or radiating spokes afford free air circulation, and the distance of the pins apart is sufficient to prevent short circuiting by copper dust, which is never present in any quantity, owing to the light contact of the brushes and consequent small amount of copper dust formed.

The method of winding the armatures is such that it enables an armature to be rapidly, hence cheaply wound, and also does away with all crossing of wires in the different sections, the end wires of each section being both outside wires.

I would call your attention to one feature in the construction of these dynamos which has its importance, and that is the facility with which the dynamo can be taken to pieces, and as easily put together, all machines of the same class having their parts interchangeable. By removing

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four screws in one end plate, which is then detached from the four magnet bars, the end plate may be then pulled off; by removing two bolts which support the centre bearing, the shaft, armatures, and commutators are removed; by loosening a screw in each armature, these, with their commutators are slipped from the shaft; by unscrewing the four screws in the remaining end plate, the field magnets are taken out, and the whole machine is now dismantled. Each armature is mounted on a brass hub, from which, like the spokes of a wheel, radiate 6 to 12 screws (the number depending upon the size of armature). These screws abut against metal shoes, the screws forcing the shoes against the interior of the armature thus forming a firm support for the same. The hub is fastened to the shaft by a key, and kept in place by a set screw. These radiating screws enable the armature to be nicely balanced on the shaft, and at the same time offer no obstruction to the free circulation of air. This hub of brass is extended, and to it is fastened the commutator, enabling the armature and commutator to be taken off the shaft without disturbing the balance or centering. The end bearings are of gun-metal, long, carefully centered, and fastened to the end plates by a single large nut on the outside. The brush holders are fastened, so as to be easily removed, to two arms extending from a cast iron ring, and diametrically opposite; this ring turns freely about the gun-metal bearing, and has a thumb-screw, by means of which it can be set in any position; it is also provided with a simple grease catching device. The two pole pieces are fastened by countersunk screws to the round magnet bars, and are bored out to proper size, such that the armatures shall just clear them in revolving; this clearance is never greater than $\frac{1}{16}$. The armatures are carefully bound by three or more bands of finest steel wire, wound under strain, and made hot by the friction of this strain, and finally carefully soldered, making a strong and neat band of metal.

The commutators and armatures have a great number of sections, hence the current is as nearly continuous as is possible to obtain.

In the construction of the armatures the same simplicity of mechanism is maintained. One noticeable and important feature must not be overlooked, the perfect insulation of the electrical circuit from the frame work. As above stated, the armature is firmly fastened to the shaft by the adjustable spokes or screws, 6 to 12 in number, radiating from and working in the hub of brass. These screws are capped by shoes of metal, which are again capped by shoes of well seasoned wood. Between the wood and the inside of the armature are two or more thicknesses of canvas. By means of the adjustable spokes the shoes are firmly pressed against the inside of the armature, and the armature thus rigidly fastened to the hub, accurately centered and thoroughly insulated.

As previously stated, this hub is keyed to the shaft, and kept from sliding endwise by a set screw. The hub is extended through the commutator, which is also fastened to the hub, independently of the armature, and hence no strain is brought upon the wire connections. The core of the armature is composed of soft iron, properly and thoroughly well insulated.

The sections are wound, as in the Gramme armature, and the ends of the sections connected in series with the corresponding sections of the commutator by screws in each post on that section. The coupling of this form of machine is similar to that shown in the first diagram, changed only to enable the two armatures to rotate in the same direction, as shown in the diagram figure 3.

Before giving electrical and other details, I will mention some of the adaptations which are peculiar to this machine. The dynamo can be used to maintain two independent circuits of the same or different potential. It can be used to transform currents of a high potential into currents of low potential and vice versa. In the case of either arc or incandescent, one half the number of lamps can be operated without corresponding waste of power. As I have been asked whether this dynamo can be run if coupled, so as to produce two poles of like polarity, *i. e.*, two north or two south poles, I will say yes, it can and has been done, the

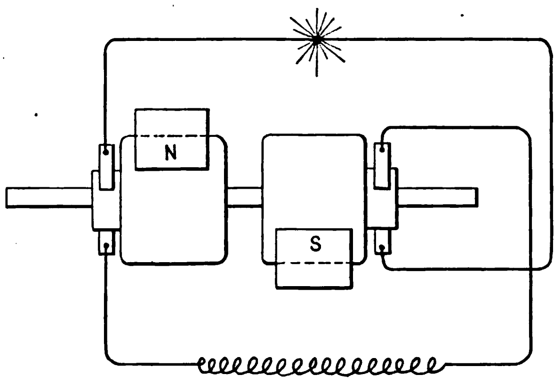

FIGURE 3.

other poles appearing in the end frames. As a fact, there is a loss of about two-thirds of the current, half of the magnetism being thrown into the end frames, becomes not only idle, but reacts through the shaft, and forms poles of like polarity, hence opposed in effect. It is but an experiment which has no practical use.

Another fact has been seriously questioned and doubted, but I think I may safely say *only* by those who have not tried the same for themselves, and that is the existence of a line of neutrality in the field bars, or line of no magnetic force, attractive or repulsive. That this is a fact, I call upon the president to verify, and it is situated a little to one side of the centre of the field magnet, opposite the pole piece. I do not allude to the armature, which shows two strong poles.

As to advancing any theory regarding this arrangement of one pole to each armature, I beg to be excused; but I will say that the following seem to me some of the chief reasons for its high efficiency as a generator.

The distribution of a given amount of wire over two armatures, thus bringing the *core* of the armatures nearer the pole pieces than is possible in the "bipolar" machines, and the consequent thin covering or small number of layers of wire over the core, thus enabling a more rapid dissipation of heat, and also a higher peripheral velocity of the core under the same circumstances (the periphery of the core being further from the centre of rotation). I call your attention to this section of wire cut from the armature of a well-known make of dynamo of the Gramme type.[2] The dynamo from which this large and charred section was taken had been running about 2,500 hours, giving 800 volts, 8 ampères. It will be seen it is 13 layers deep, No. 15 wire (B. & S. gauge) with three layers of cotton covering, which may have been paraffined. Its dimensions are, 10 ins. long outside, $6\frac{3}{4}$ ins. inside; $3\frac{3}{4}$ ins. deep outside, and $1\frac{1}{4}$ ins. inside. This weighs $20\frac{1}{2}$ ozs. 100 sections = 2050 ozs. = 128 lbs. It will be seen the first five layers are badly charred, the charring decreasing as it nears the outer layers, disappearing entirely at the outside. This would point to the core as the point of highest temperature, which was, however, charred only on the outside. There are about 110 ft. of wire in each of these sections.

Now compare it with this section[3] from a Ball "E" dynamo which has run 2,500 hours, with 950 volts 8 ampères. This is five layers deep, No. 17 wire (B. & S. gauge) covered with two layers of cotton, but no paraffine or other insulating compound. Each of the armatures contains 90 sections, and each section about 36 ft. of

2. The sample of wire here exhibited, was so thoroughly charred that insulation was destroyed.
3. This sample of wire bears no evidence whatever of any heating effect.

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wire. Its dimensions are, $6\frac{3}{8}$ ins. long outside; $5\frac{5}{8}$ ins. inside; $1\frac{7}{8}$ ins. deep outside, and $1\frac{1}{8}$ ins. inside. Weight, 4.1 ozs.; 90 sections = 23 lbs.; 180 sections = 46 lbs. I think the comparison is considerably in favor of the Ball system, both machines being about the same capacity; the former 18 lamps, the "Ball" 20 lamps. Again, in the core of each armature of the Ball dynamo, there is about the same amount of iron as is in the single armature of a "bipolar"; thus enabling the machine to carry a greater current before becoming saturated. This may, it seems to me, explain why the capacity of a Ball dynamo can be nearly doubled without danger, and also may account in part for the low temperature of its armature when in action, particularly noticeable at high speeds, there being double the amount of mass in the cores of the two armatures combined.

The following comparisons of weight of material on machines of different systems may be of interest, and if they are not close approximations to the truth, I need only allude to the great difficulty in obtaining such facts as my apology for any errors. In the case of the Ball dynamos I can vouch for their accuracy.

	"Unipolar."	"Bipolar."
Weight of copper wire required (per arc light)	7 to 10 lbs.	25 to 40 lbs.
Weight of other metal, iron, &c., do	22 to 42 "	15 to 180 "
Total weight of all, do	39 to 50 lbs	100 to 220 lbs.

COMPARISON OF BALL 20-LIGHT AND BRUSH 16-LIGHT.[4]

	Ball.	Brush.
Copper wire per lamp, on armature	$2\frac{1}{3}$ lbs	7 lbs.
" " " on magnets	6 "	54.2 "
" " " on machine	$8\frac{1}{3}$ "	61.2 "
Total weight of machine per lamp	39 "	147.0 "
" " (about) per horse power	65 "	147.0 "
" " copper " "	14.1 "	61.0 "
" " of copper on machine	.170 "	979 "
" " of machine	780 "	2,352 "
Periphery speed of armatures	3,800 ft.	3,900 ft.

4. Machine of 1882–1883 (old style armature).

WEIGHT OF PRINCIPAL ARC-LIGHT DYNAMOS.

	"Unipolar."	Thomson-Houston.	Brush.	Weston.
5-light machine	300 lbs.	1,000 lbs.	1,150 lbs.	450 lbs.
10 " "	520 "	2,000 "	1,500 "	1,200 "
12 " "		2,200		
16 " "		3,000 "	2,352 "	2,000 "
20 " "	780 "	3,300 "		2,400 "
35 " "	1,360 "			

WEIGHT OF INCANDESCENT DYNAMOS.

	"Unipolar."	Edison.	Weston and Exciter.	Brush Victoria.
45 lamps	300 lbs.			
60 "	500 "	3,000 lbs.	2,575 lbs.	
80 "	500 "			
100 "	750 "	4,500 "	3,775 "	1,350 lbs.
125 "	750 "			1,350 "
150 "	1,000 "			1,600 "
180 "	1,000 "	6,000 "		1,600 "

NOTE.—The total weight of machines other than the "Ball," are in the main taken from the catalogues of the various companies.

I wish to avail myself of the opportunity here offered of denying a statement made by an electrician prominent enough to be more careful in his *misstatement* of facts so liable to injure others; and for fear it may be thought I mean some one of the many who applauded the discourteous, certainly untruthful statement, I will say, I allude to the report of the remarks made by Prof. Silvanus P. Thompson, before the National Conference of Electricians at Philadelphia, as printed in the *Electrical Review* (London) December 13, 1884. After calling attention to the "bad design" of the machine, and admitting with much condescension that "it *may* work," because "it is hard to have a dynamo machine with a Gramme ring in it that does not work," the professor goes on to say that the lines of force "spread out into the air": "I examined this machine once in England" (probably just as he examined it here), "and I saw a similar machine in your exhibition;" and as a proof of his statements adds: "It seemed to me to be a striking commentary on the omission of the pole piece that over that machine *alone* of all machines in the Exhibition, there was a sign which ran: '*Do not approach this dynamo for fear of magnetizing your watches*'." ("Laughter and applause.")

The truth is this: at the beginning of the Exhibition the management warned the public against dynamos, by tacking up or suspending over each dynamo stand a card saying: "Dynamos will magnetize watches. Keep away." In a very short time the only cards allowed to remain, was one over the "Edison" (which the professor evidently did not see), and one over the Ball dynamo. I may also say there was an establishment close to the entrance to the exhibition which advertised to take charge of watches of visitors, *probably for fear of being damaged by the Ball dynamo.*

This may seem a trifling matter; so it would be were it the only instance of a deep-rooted prejudice, or unscientific ignorance of facts which has been published several times against the Ball dynamo, in addition to similar remarks at its expense made at this conference of scientific men. Contrast the remarks of this distinguished English scientist with the manly tone of Prof. Nipher, who virtually replied to Prof. Thompson: "It occurs to me to say a few words in regard to an unfortunate machine which has been referred to several times, and which I saw the other day for the first time. It has two armatures and only two pole pieces. I was as much astonished as anybody could be when I saw it, but when I was informed that it weighed less than one thousand pounds, and maintained a high strength of current, I thought it worth while to investigate what the machine would do, before we said too much about how it worked."

Now I would like to ask why has so much antagonism been manifested against the Ball dynamo? It cannot be said the machine is bad, for every test made upon it has proven the fact to be otherwise. It cannot be said the machine does not work well and economically, for the most careful tests place it second to none in electrical economy. It cannot be called an expensive machine, for you can ascertain the fact for yourself, that there is none cheaper to buy. It must cost lest than many others, as there is less material and no more work upon it.

I remember a little incident which occurred two years ago, when I represented this machine in London. I received a visit from Mr. Latimer Clark, an eminent English Electrical Engineer. Almost his first words to me were: "Mr. Raymond, I don't like the looks of that machine; it is built wrong, constructed upon entirely wrong principles, and I would almost be willing to stake my reputation that it won't work." I said nothing, but allowed him plenty of time to examine the dynamo. When I started the machine and closed the circuit the machine was doing its best, and the six fully 2,000 c. p. arcs lit up the shop, the gentleman was startled; he looked first up at the lamps, then at the dynamo; after a little he put his hand to his head and said: "I am vexed, very much vexed." "Why," I asked. "Because," said he, "all my experience and practice of the past thirty years teaches me that that machine is built wrong, wound wrong, ought not to and cannot work, but, confound it, it does, and very nicely, too!" Mr. Clark today is one of the few prominent English electricians who admits the good qualities in the Ball dynamo, and I trust he will pardon me for telling tales out of school.

I cannot understand why, if a test is made disproving the antagonistic statements, the tests are questioned, no matter what the integrity of the expert may be. If test after test is made, each confirming the previous ones, still no admission from the opponents. I should not be so much surprised if these remarks, this prejudice, was confined entirely to slow-going Britain; but even in this country, noted for its quick appreciation of merit, do I find this prejudice, and I regret to say only in scientific circles, so opposed as it is to all true scientific thought. It recalls the old saying: "History repeats itself," and painfully sug-

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gests those well known instances of the infallibility of scientific men. Let me in closing quote one or two of those instances which are now historical.

Wood, in 1825, wrote: "Nothing can do more harm to the adoption of railroads than the promulgation of such nonsense as that we shall see locomotive engines traveling at the rate of 12, 16, 18 and 20 miles per hour."

Dr. Lardner, an eminent English mathematician, published a treatise to prove that no steamship could ever cross the Atlantic ocean, and the steamer "Sirius," a few weeks later, brought the first copies of his pamphlet to America."

"Babinet, the French calculator, declared no telegram could ever be transmitted through the Atlantic ocean to America." Edison did not escape entirely intimations of insanity when he first began to talk electric light, and Sir Humphrey Davy himself "gave it as his opinion that it would be as easy to bring down a bit of the moon to light London as to succeed in doing so with gas!"

Brooklyn, N. Y., Jan. 13, 1885.

The following tests and details of the Ball machines are from reports and records as mentioned.

From a report made by Robert Sabine, Esq., C. E., in March, 1883, upon the earlier form of the Ball dynamo, since which time great advances have been made in regard to efficiency, total weight, and weight of copper on machine:

Current in circuit	15.0 ampères.
Difference of potential between terminals	195.0 volts.
Resistance of dynamo (hot)	4.5 ohms.
Expended upon machine for electrical work	5.68 horse power.
Accounted for in outer circuit	3.92 "
" " in inner "	1.35 "
The proportion accounted for electrically	93.1 per cent.
Accounted for in lamps	69.2 "

Photometric measurements on *one lamp* out of six, as follows:

Current in lamps	13.9 ampères.
Potential difference	40.1 volts.
Accounted for in lamp	0.75 horse power.

Illuminating effects were as follows:

Position of arc with regard to photometer.	Observed. Standard candles.	Illuminating Power. Per 1 h.p. accounted for in the lamps. Standard candles.
22 deg. below	602	802
11 " "	626	835
Horizontal	887	1,183
11 deg. above	1,213	1,617
22 " "	1,831	2,441
31 " "	1,859	2,479
35 " "	1,690	2.253

The following are records of tests taken in New York City by the Ball Company—1883:

TEST OF C NO. 0.

(Style of machine no longer manufactured.)

Weight of dynamo	505 lbs.
Copper wire on fields	103 "
" " armatures	48 "
" " machine	151 "
Diameter of armature	11 inches.
Resistance, field (cold)	1.35 ohms.
" armatures (cold)	1.80 "
" machine (cold)	3.20 "

Running 8 arc lamps, 2,000 candle-power nominal—

Revolutions	1,465 per minute.
Current	18 ampères.
Electromotive force, external	251 volts.
Gross horse-power	5.50
Gross efficiency	92 per cent.
Net "	$79\frac{3}{10}$ "

With 7 arc lamps—

Revolutions	1,425 per minute.
Current	13.5 ampères.
Electromotive force, external	240 volts.
Gross horse-power	5.60
Gross efficiency	92 per cent.
Net "	$78\frac{3}{10}$ "

Running 6 arc lamps—

Revolutions	1,300
Current	13.1 ampères.
Electromotive force, external	219 volts.
Gross horse-power	5.0
Gross efficiency	93.5 per cent.
Net "	78.1 "

By *gross horse-power* is meant the horse-power given to generate the current, and does not include friction of dynamo.

TESTS OF C NO. 5.

(Style no longer manufactured.)

Weight of dynamo	500 lbs.
Copper wire on fields	84 "
" " armatures	49 "
" " machine	133 "
Diameter of armatures	11 inches.
Resistance, fields (cold)	1.62 ohms.
" armatures (cold)	1.88 "
" machine (cold)	3.5 "

Running 9 arc lamps (not up to candle-power) 2,000 c. p.—

Revolutions	1,465
Current	12.5 ampères.
Electromotive force, external	250 volts.
Gross efficiency	92 per cent.
Net "	$77\frac{3}{10}$ "

Running 8 arc lamps, 2,000 c. p.—

Revolutions	1,430 per minute.
Current	13.4 ampères.
Electromotive force, external	246 volts.
Gross efficiency	92 per cent.
Net "	$76\frac{3}{10}$ "

TEST OF INCANDESCENT DYNAMO. SERIES WOUND, ARMATURES AND FIELDS IN PARALLEL.

Weight of machine	525 lbs.
Copper wire on fields	102 "
" " armatures	49 "
" " machine	151 "
Resistance, fields (cold)	.084 ohms.
" armatures (cold)	.112 "
" machine (cold)	.200 "
Diameter of armature	$11\frac{1}{4}$ inches.

Running 60, 20 candle power, 50-volt., 1 ampère lamps.

Revolutions	1,210 per minute.
Current	60 ampères.
Electromotive force, external	52 volts.
Gross horse-power	5.55
Gross efficiency	93 per cent.
Net "	$75\frac{3}{10}$ "

TEST OF 20 ARC LIGHT DYNAMO.

(Style no longer manufactured.)

Weight of machine	1,262 lbs.
Copper wire on fields	180 "
" " armatures	69 "
" " machine	249 "

Running 20 arc lamps and with 1.1 ohms. line resistance.

Revolutions	1,300 per minute.
Diameter of armatures	12 inches.
Current	13 ampères.
Electromotive force, external	837 volts.
Gross efficiency	91.5 per cent.
Net do	82.2 "

"E" MACHINE.

(Style now manufactured.)

	H. P.
20 lights—Revolutions 1,380.	
(a) Total actual belt h. p.—required with full load	12.85
(b) " " " " on normal short circuit	2.56
(c) " " " " for friction	0.43
(d) " " " " " air blast	0.09
(e) Electrical h.p. in external circuit (8.05 ampères, 956 volts).	10.31
(f) " " of all the circuit measured by dynamometrical pull on reproduced current[5]	12.01
Resistance of machine .22 ohms.	
" external circuit = $\frac{956}{8.05}$ = 118.7 ohms.	

5. Brackett's dynamometer.

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LITERATURE.

REVIEWS.

The Quadruplex, by WILLIAM MAVER, JR., and MINOR M. DAVIS, *With chapters on the dynamo-electric machine in relation to the Quadruplex; the practical working of the Quadruplex; Telegraph Repeaters and the Wheatstone Automatic Telegraph by* WILLIAM MAVER, JR. New York: W. J. Johnston, 1885.

IT will no doubt be within the memory of those who were engaged in telegraphy 25 or 30 years ago, that a telegraph operator was then considered hardly competent to fulfil the duties of his position, unless he understood and could perform with his own hands almost every kind of work pertaining to the service. It was necessary for him not merely to be able to transmit and receive communications over the wires, but to take in messages over the counter, and in many cases to act as his own delivery messenger and to keep his own books; he was moreover expected to attend to his own batteries, both main and local, to keep in repair a certain section of the main line, and build or rebuild it when necessary, and even to repair his own instruments unless perchance the damage happened to be of a serious character. Hence we find that the more intelligent of the early operators were men thoroughly well-informed in relation to all the details of the service, who could satisfactorily perform the duties of any position from messenger-boy up to general superintendent.

With the enormous development and growth which the modern telegraph system has attained, the service has become more and more specialized. The division and subdivision of labor plays at the present day a no less prominent part in telegraphy than in almost every other branch of business. It is a source of satisfaction to us to observe that a corresponding change is evidently taking place in the character and scope of telegraphic literature. Voluminous and expensive general treatises covering the entire field of telegraphy no longer possess their former importance or value, for under the present, and still more under the future organization of the service, no one person can be expected to become familiar with the details of every department of practical telegraphy. Hence there exists a real want which thus far very little has been done to supply; that of special treatises of moderate size and cost, written in plain and intelligible language by authors who not only have the necessary practical knowledge, but what is equally important, the ability to impart it in a clear and comprehensible mannner to others. This is precisely what the authors of the present work have endeavored to do for the practical operators employed in working certain special classes of modern telegraphic apparatus, and we may as well say at the outset, that they have not only shown themselves eminently well qualified for the particular work they have undertaken to do, but have executed it with a conscientious thoroughness that leaves little to be desired.

The first chapter contains an abridged historical sketch of the quadruplex, mainly compiled from Prescott's *Electricity*, showing the numerous modifications which were undergone by the apparatus during what may be termed its experimental period, extending from its first introduction on the line between New York and Boston in 1874, down to the time when the present standard plant was arrived at, which was some 5 or 6 years ago. They then take up the apparatus in its present form and proceed to set forth its principles, its construction and its mode of operation. The manner in which the particular elementary facts of electricity and magnetism upon which the operation of the quadruplex depends,

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"G" MACHINE.

35 lights, 8.2 ampères, 47 volts each		
Weight of copper on field	150 lbs.	No. 12 (B. & S. gauge.)
" " armatures	102 "	No. 16 (" ")
Copper per light	7.2 "	
Resistance of machine	28.4 ohms.	

ESTIMATED H. P. REQUIRED.

	H.P.
Friction	0.75
Internal resistance	2.56
Wasted in core, etc	0.27
External circuit	18.00
Estimated total h. p.	21.58

Estimated net commercial efficiency	$83\frac{1}{10}$ per cent.
Revolutions	1,180
Weight of machine	1,360 lbs.

DEDUCTIONS.

Total h. p. exclusive of friction and air blast		12.33
Electrical h. p. in circuit	Method e, { 10.31 ext. 1.89 int. }	
	Method f,—12.01	12.01
Coefficient of conversion excluding friction and air blast (by method f)		$97\frac{1}{10}$ per cent.
Coefficient of conversion including friction and air blast (by method f)		$93\frac{5}{10}$ "
Net commercial efficiency ([illegible])		$80\frac{1}{10}$ "
Total weight	780 lbs.	
Diameter of armature	$10\frac{3}{4}$ inches.	
Bore of pole pieces	11 "	
Width or face of armature	6 "	
Copper on each armature	23 lbs. No. 17 — 46 lbs.	
Copper on field	125 lbs. No. 12 — 125 "	
Total copper on machine	171 "	
Copper per light	8.6 lbs.	
External diameter of core	$10\frac{1}{16}$ inches.	
Internal diameter of core	8 "	

The following tests of an "E" dynamo constructed nominally for supplying 10 arc lamps were made by H. Alabaster, Gatehouse & Co., in April 1884. They agree very nearly with the results obtained by Mr. Robert Sabine from an old style machine a year previous.

The potential difference of the machine between terminals was measured by the condenser method, a Clark's standard cell being employed for comparison of electromotive forces. Two Siemens' electro-dynamometers, one of these being supplied by us, indicated the current strength, each instrument giving identically the same readings. The external resistance, and that of the machine, were measured immediately after each test. Horse-power measurements were taken by means of a Morin transmission dynamometer and a Prony brake.

Countershafting was placed between the dynamometer and the dynamo, the former being so arranged as to run at about the same number of revolutions per minute for varying speeds of the dynamo, this being accomplished by using pulleys of different diameter on the latter. The Prony brake, which was balanced, gave admirable readings, there being but a difference of 2 ounces in the weight applied at the end of the lever in 3 distinct measurements.

The principal test was made as nearly as possible under the same conditions of speed and current as that taken previously by the Silvertown electricians. The results obtained by us are tabulated as follows:

No. of Test.	Current in Ampères.	Resistances in Ohms.			Electrical Work.				Mechanical Work. Prony Brake.			Revolutions of Dynamometer.	Morin Dynamometer.			Percentage of Efficiencies.				Revolutions of Machine. Average.
		External R—r.	Dynamo r	Total R	Watts $C^2 R$	H.P. External.	H.P. Internal.	H.P. Total.	Weight in lbs.	Length of lever, feet.	H.P. absorbed.		Pull machine loaded. Kilog.	Pull machine empty. Kilog.	H.P. Calculated.	Conversion.	Appearing in External Circuit.	Commercial calculated from absorbed H.P.	Commercial.	
A	8·07	56·0	17·15	73·15	4764	4·888	1·497	6·385	....	....	....	378	69	14	6·83	93·5	76·5	71·5	63·3	[illegible]
B	8·07	68·8	16·93	85·73	5583	6·00	1·479	7·479	... ...	....	....	365	89	20	8·28	90·3	80·3	72·4	....	[illegible]
*A	8·07	59·33	17·12	76·45	4980	5·179	1·494	6·674	13·94	2	6·9	384	75	18	7·16	93·2	77·6	72·3	67·3	1300
													Prony Brake			96·7	"	75·0	70·0	......

OBSERVATIONS.—Test *A is nearly a reproduction of test A, and to it was applied the Prony brake; in 3 separate measurements at varying intervals the weights applied at the end of the lever were 13 lbs. 15 oz., 13 lbs. 14 oz., and 14 lbs. respectively. The formula is $\frac{n \times L \times x}{5252}$ where n is the number of revolutions per minute, L the length of lever, and x the weight. The formula for the Morin transmission dynamometer is $\frac{1\cdot5 \times K \times S}{60 \times 76\cdot04}$ where S is the speed and K the indicated pull in kilos on the dynamometer less the pull when the circuit is open. When the Prony brake was employed to measure the absorbed h.p. the Morin instrument was used as an indicator. Thus, when electrical work was being produced with the machine running at 1,300 revolutions the Morin indicated 75 K, this pull was then reproduced in the Prony brake test with the machine running at the same speed. The commercial efficiency of the machine is calculated both from the absorbed h.p. alone and with the addition of the h.p. which the machine requires to run at 1,300 revolutions unloaded = 0.54 h.p. Test B, at a higher speed, was taken at the suggestion of Mr. Ball. In test *A the Prony brake was resting by its own weight upon one of the pulleys of the dynamo when doing electrical work, and also when running empty. The external circuit was, in each case, made up of a wire resistance.

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are explained and illustrated, is worthy of the highest commendation. This is especially noticeable in reference to the divided circuit, the differential or neutralizing electro-magnet and the condenser.

In the succeeding chapter the Stearns duplex is first explained, and then the polar duplex. These explanations prepare the student to comprehend without difficulty the essential principles upon which the operation of the quadruplex depends, it being, from the point of view taken by the authors, simply a combination of these two duplex systems.

Prior to the year 1881 the numerous quadruplex lines radiating from the Western Union Telegraph building in New York were operated by voltaic batteries, but at that time certain modifications were made in the apparatus to enable it to work upon currents produced by the dynamo-electric generators which had already been introduced by Stephen D. Field for operating the single circuits. A description is accordingly given of the system of dynamo-electric generators now in use by the Western Union company in New York, together with a full explanation of the manner in which the lines are operated in connection with them. This description is exceedingly good and is of much professional interest, having never before appeared in any treatise on telegraphy. It is followed by an equally good description of the modified quadruplex apparatus, as adapted to the new system.

This portion of the work is completed by a chapter on the practical management of the apparatus, in which the numerous faults—or, as they are technically termed, "bugs"—which infest the quadruplex (and it is not too much to say that these electrical insects are numerous and troublesome) are pointed out, their causes explained and their remedies set forth. The most cursory examination will show that this chapter was written by one who thoroughly understands the subject. It is the work of a "practical man" in the best sense of the word, and is skilfully addressed to the comprehension of the average operator. We cannot forbear to quote the final paragraph of this chapter, for, to use a phrase more expressive than classical, "we have been there ourselves."

It would undoubtedly add much to the successful handling of the quadruplex if every one connected with it would frankly state the cause of trouble, when he has found it, to the operator or person in charge at the other end. The latter has seen the symptoms occasioned by the trouble. If he were at once notified as to the exact nature of the fault he would be able at once to direct the distant station to the seat of trouble when next the same symptoms should manifest themselves, and thus time would be saved. Instead of so doing, it has become almost a rule for every manager to hide any trouble happening in his own set, and merely to say that probably a loose wire "shook out," or something equally vague. This pernicious custom is probably due to the fact that some superintendents require so many explanations as to the reason why such and such trouble was not obviated, or not discovered sooner, that a manager rarely allows a fault to be definitely located in his office more than once. It is thus, perhaps, an open question whether it is really to the benefit of the service that managers, who, as a rule, are not apt to wilfully allow trouble to occur, or to sit idly by when it has occurred, should be held so strictly to task.

The chapter on repeaters possesses the same excellent qualities as those on the quadruplex. The general principles on which the working of the combined circuit depends are first laid down. The descriptive portion of the text is wisely confined strictly to the apparatus in every-day use, viz., the Button, the Milliken and the Toye repeaters. A brief but sufficient explanation is also given of certain special plans of repeaters for combining single circuits with duplexes and quadruplexes. The directions for managing or adjusting the several forms of repeaters are not very lengthy, but appear to be sufficient. A chapter on the Wheatstone automatic system, which has already gained something of a foothold in the United States, and which will not improbably come into more extensive use in the future, completes the volume.

It is seldom that we have examined a work of this kind in which there is so much to commend and so little to criticise. In fact, the work is so simple in its aim and so unpretending in its execution as to disarm unfriendly criticism. It is nevertheless essentially original, not only in its subject-matter but in its treatment. Even that *bete noir* of the telegraphic student, "algebra," is conspicuous by its absence.

The volume is profusely illustrated with original diagrams, which have been exceedingly well drawn by Mr. Mailloux, and these for the most part are very fairly engraved. There is at least this to be said for the illustrations, that they are actually illustrative of the text; in fact, it would be difficult to find one of which it can fairly be said that it has been introduced solely for pictorial effect.

The paper and printing of the work are not all that could be desired in a treatise of this kind. This is the more to be regretted as other works issued by the same publisher—for instance, Lockwood's *Information for Telephonists*—have been quite unexceptionable in this respect.

There is a fine opportunity at the present time for some enterprising publisher to bring out a series of inexpensive practical manuals of the same general character as the book under review, treating of the different branches of the telegraphic service, somewhat upon the plan, for example, of Hartleben's admirable *Elecktro-technische Bibliothek*. If the authors were wisely selected such an undertaking could hardly fail to be successful.

NEW PERIODICALS.

Industrial America; a popular record of progress in the arts and sciences. Published every other Saturday by W. J. Johnston, New York.

The subjects which come within the scope of this journal are so numerous, that an ordinary mind would perhaps hesitate before attempting to cover "the entire field of industrial progress." The development of industry in modern days tends rather toward its division into numerous branches, each of which as its importance becomes recognized, is represented by one or more periodicals, devoted especially to its chosen mission. There can be no doubt, however, that from this vast field, sufficient new and interesting matter may be obtained to more than fill all the space which a publisher can devote to its presentation. The reader who looks to illustrated mechanical literature for entertainment should be well satisfied with the selection of topics treated in this publication.

CATALOGUES AND PAMPHLETS RECEIVED.

Buckeye Engine Company, Salem, O. Descriptive catalogue devoted more especially to their excellent automatic cut-off engine, but containing information of value to every person interested in steam power. Elegantly printed and illustrated.

I. W. Colburn & Co., Fitchburg, Mass. A very complete description of the dynamos, arc and incandescent lamps of various patterns manufactured by this well-known firm. Fully illustrated and giving an excellent idea of the apparatus sold by them, which includes small dynamos for experimental and electro-plating purposes.

Waldumer Electro-Magnetic Brake Co., Cincinnati, O. Annual report for year 1884. The pamphlet contains testimonials from practical railroad men, commending the working of the apparatus in actual use.

RECENT PUBLICATIONS.

American Bell Telephone Co. *et. al. vs.* The People's Telephone Co. *et. al.* United States Circuit Court, Southern District of New York. Argument of E. N. Dickerson for complainants. 8°. 165 p., boards. Boston: *A. Mudge & Son.*

Beard, G. M., M. D. and A. D. Rockwell, M. D. Practical Treatise on the Medical and Surgical Uses of Electricity. Fourth ed., rev., by A. D. Rockwell, M. D. 8°, 753 p., cloth, $5.50; leather, $6.50. New York: *W. Wood & Co.*

Cadiat, E., and Dubost, L. Traité pratique d'électricité industrielle. Paris: *Baudry*, 1885. 496 p., illustr. 8°. 15f.

Chicago Commerce of 1884. A review of the leading branches of trade and manufacture. Chicago, *S. Ferd, Howe & Co.* 256 p. 8°. $2.00.

Grange, E. Contribution à l'etude du mécanisme de la mort par les courants électriques intenses servant à la lumiere électrique, au transport de la force, etc. Paris: *Masson*, 1884. 42 p. 8°.

Higgs, P. Magneto and dynamo electric machines, with a description of electric accumulators. London: *Symons & Co.* 13+301 p., illustr. 8°.

Hospitalier, E. L'électricité maison. Paris: *Masson.* 310 p., illustr. 8°.

Maver, W., jr., and Davis, M. M. The quadruplex, with chapters on the dynamo-electric machine in relation to the quadruplex; the practical working of the quadruplex; telegraphic repeaters, and the Wheatstone automatic telegraph. New York, *Johnston*, 1885. 128 p. 8° illustr.

Terry, A. C. and Finn, W. Illustrations and descriptions of telegraphic apparatus. Buffalo, N. Y. [*Terry*] 1884, 92 p. Plates, long 12°.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.

The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.

In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.

Sketches and drawings for illustrations should be on separate pieces of paper.

All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

HEATING AND LIGHTING RAILWAY CARS BY ELECTRICITY.

[29]—Is there any reason why the cars of the New York elevated railways cannot be heated and lighted as well as propelled by the electric current from a central station? At the Philadelphia exhibition I noticed that a rack full of incandescent lamps in the exhibit of the Brush electric company, gave out a great amount of heat, giving one, in fact, the feeling of standing in front of an open fire-place, thus showing that it is at least possible to warm one apartment in this manner. H. J. C.

NEW YORK, Dec. 25th, 1884.

It was proposed by Edison, 3 or 4 years ago, to light an electric railway car with the same current used to propel it. There is apparently no reason why it may not be done successfully. With regard to heating, the question is different, as the cost of the method is so great as to forbid its practical use. The original, energy of coal, is converted first into steam, then into motion

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then into electricity, and then back again into heat. At each conversion a considerable amount of energy is lost. By generating steam, and warming by direct radiation, it is possible to utilize as much as 60 per cent. of the total heat energy contained in the coal consumed, while by the electrical method, not more than 5 to 10 per cent. could possibly be realized. It is said that M. de Meritens is now experimenting with electrical foot-warmers in Paris, for railway use. The following table shows the losses by conversion :

TABLE SHOWING HEAT UNITS PER LB. OF COAL, AND PER CENT. UTILIZED IN STEAM-ENGINES, AND UNITS AVAILABLE FOR HEATING BY ELECTRICITY. (R E. Crompton.)

	Total heat units.	Per cent. utilized.
Heat units per lb. of coal, mean of 97 kinds. (British government experiments)..........	13,006	100
Units available in evaporation of water. (British government experiments)	8,033	62
Units in horse-power, best steam-engines. (1 5 lbs. per h. p. per hour)......................	1,715	13.2
Units in horse-power. Good average commercial steam-engine. (3 lbs. per h. p. per hour)........................	857	6.6
Units available in heating coil in external circuit of good dynamo, utilizing 70 per cent. of h. p., with 1-5 lb. engine..	1,200	9.25
do. do. with 3 lb. engine.............	600	4.6

[This table shows that indirect heating by electricity must necessarily be from 7 to 13 or more times as costly as direct heating with steam, in the mere matter of coal, to say nothing of the increased cost of plant and attendance.—EDITOR.]

CORRECTION IN TABLE OF ELECTRO-CHEMICAL EQUIVALENTS.

[30.]—I was much interested in the communication of Mr. Geo. B. Prescott, Jr., page 7, January number of your journal. There are, however, some mistakes probably arising from want of care on the part of the author, which are quite misleading. Columns 6, 7, 8, and 9, for Al. and Mg. should read :

	Col. 6. (q.)	Col. 7. (w.)	Col. 8. (Log. q.)	Col. 9. (Log. w.)
Al.........	10583.00	.34018	4.0245939	$\bar{1}$.5317086
Mg.........	8040.00	.44747	3.9055411	$\bar{1}$.6507614

The table is undoubtedly a very useful one with the exceptions of above. EWING MCLEAY.

Greencastle, Ind., Jan. 18, 1885.

QUESTIONS AND ANSWERS.

[51.]—**Electromotive Force and Potential.**—S. B. T., Phila., says: 1. I am studying Sprague's *Electricity* and find his definitions of potential and E. M. F. so obscure as to be wholly unable to comprehend them Will you please explain these terms and their difference? 2. Is E. M. F. the cause or effect of electricity? 3. Is the difference of potential the same between any 2 points in a conductor, if the points are equally distant from each other? Please answer plainly as there are many who are ignorant of these same terms. **Ans.**—1. A full explanation of the difference between potential and electromotive force is given in vol. iii, page 140 of THE ELECTRICIAN AND ELECTRICAL ENGINEER, (July, 1884). We do not see how the matter can be explained any more clearly. 2. The cause of electricity is not known. Electromotive force is the cause, not the effect, of an *electric current*. It may be likened to the head or height of water in a reservoir, and potential to the pressure of the water at the bottom of the same reservoir. The strength of a current of water from the reservoir therefore depends upon the pressure, and the pressure depends upon the head. So also the strength of an electric current depends upon the potential, and the potential depends upon the electromotive force. 3. The difference of potential is the same between any 2 equidistant points in a conductor provided the conductor is of uniform resistance. If the resistance of the conductor is the same between any 2 points then the difference of potential between them will be equal.

[52.] **Resistance of Railway Track.**—J. M. McC., New York, inquires how the electrical resistance per mile of a railway track can be computed? **Ans.**—If the rail were continuous its resistance might be computed from its weight per mile, but there are 175 joints in each mile, the resistance of which would depend upon the perfection of the connecting device. The resistance is computed from the weight by means of numerical coefficients, the rule being to divide the coefficient of the required metal by the weight per mile and the quotient will be the resistance in ohms. We give a few coefficients deduced from the researches of Professor Hughes. (Proc. Royal Soc., Dec. 1883.) Best Swedish charcoal iron, 4,252 ; Swedish Siemens-Martin, 5,024 ; soft Bessemer, 5,917 ; hard Bessemer, 6,942 ; crucible cast-steel, 7,772. The Western Union standard for iron wire is 4,884. A line of 70 lb. per yard rail of hard Bessemer steel, would therefore give 70 × 1,760 = 123,200 ; 6,492 ÷ 123,200 = 0.00527 ohms (about $\frac{1}{190}$) per mile. The joints may be so made as not to greatly increase this figure.

[53.] **Nomenclature of Electric Circuits.—Electrical Theories.**—M. C. A., Biddeford, Me., writes as follows : 1. Is a continuous wire circuit from one terminal of a battery out and back to the other terminal called an open or a closed circuit? 2. Which is generally accepted as the correct theory of electricity, the single or double fluid? 3. Do the terms *positive* and *negative* electricity mean differences of potential, or are there 2 distinct kinds of electricity? **Ans.**—1. An open circuit is a circuit which extends from one pole to the other of the battery with the exception of a single break. When the circuit is completed at this break it becomes a closed circuit. A closed circuit is a continuous circuit through which a current flows. Work may be performed either by closing an open circuit, or by opening a closed circuit. 2. Electricity is not at the present day usually regarded as a fluid by advanced electricians, although it is frequently referred to as such in a conventional manner. Whatever it may be, whether a fluid, or a form of energy or a peculiar state of matter, it is certainly single and not double, one and not two. 3. The terms positive and negative are relative and not absolute. Wherever there exists a difference of potential, the point of greatest potential is termed positive and the point of least potential negative. In the same sense, for example, the terms heat and cold are relative and not absolute Heat and cold are not in fact two distinct things, but are merely differences of degree in one and the same thing.

[54.] **Electric Railways.**—S. M., of Mohawk, N. Y., inquires for a cheap publication, showing how railway cars are run by electricity, and particularly how several trains or motors may be run on one circuit at the same time. **Ans.**—Prof. W. E. Ayrton's lecture on Electric Railways, price, 20 cents. is the cheapest ; Dr. Adams's article completed in this issue of THE ELECTRICIAN AND ELECTRICAL ENGINEER is very instructive One of the advantages of an electric railway is that but one motor can run on each section at the same time, thus avoiding collisions.

[55.] **Bichromate Batteries.**—C. E. K., Jr., New Orleans, La., writes that he is using an "automatic" battery, a form of Grenet, with carbons 4½ by 2½ and zincs the same size, in respect to which he inquires :—1. Would a battery with elements half the above size do as well to run a small motor? 2. Comparative efficiency of a battery with only one carbon and a zinc in each cell? 3. Would it be as well to have a carbon cylinder, instead of two plates with a zinc rod in centre? **Ans.**—1. No The efficiency would diminish nearly in proportion to the lessened surface of the plates, as you will find by raising them partly from the solution. 2. We cannot say without more definite data The efficiency however would be much less, when used for a motor. 3. No. The proposed arrangement is better adapted for long circuits of high resistance.

[56.] **Effect of Temperature on Voltaic Batteries.**—W. A. P., Hartwick Seminary, N. Y., inquires : At what degree of cold (Fahrenheit) the following batteries cease to act : Gravity, Daniell, Leclanché, Grove, Grenet, Bunsen and Smee. At what temperature will the gravity battery give the most and strongest current? **Ans.**—We cannot find that any careful determinations have been made as to the effects of temperature upon batteries. All kinds of batteries appear to work most satisfactorily, all things considered, at a temperature of about 20° C (68 Fahrenheit) ; but they do not entirely cease to act even when frozen solid. The different forms of sulphate of copper battery are most easily affected by a fall in temperature, while the nitric acid and bichromate batteries are but slightly reduced in efficiency. The Leclanché cell is not very much affected by changes in temperature.

[57.] **Fixing Magnetic Figures.**—W. C. W., Erie, Pa., writes: —How can I preserve the magnetic curves formed on glass by iron filings under the influence of a magnet? **Ans.**—Coat the glass with a solution of gum-arabic and dry it, before forming the figures. Soften the gum by exposure to steam, upon drying, the filings will be fixed. Such a glass plate may be used in a magic lantern. Another method is to moisten a sheet of white paper with a mixture of 1 part each, saturated solution of ferrocyanide of potassium, and nitrate of ammonium and 2 parts water. Press it upon the filings and they will be printed on the paper in blue.

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CORRESPONDENCE.

NEW YORK AND VICINITY.

The Electric Railway Boom.—Electric Light Wires Start a Fire at Headquarters.—Mayor Low of Brooklyn Opposes Underground Lines.—The Bankrupt Telegraph Company.—Activity in the "Ticker" Business.—More Electric Lighting Wanted.—Removal of J. H. Bunnell & Co.—Electricity as a Highway to the Penitentiary.—Leclanche Jars as Jam Pots.

It appears certain that the present year will witness substantial progress in the establishment of electric railways in this vicinity. The suggestion that electricity be given a thorough trial on the elevated railways, has met with the approval of the Manhattan Railway Co.'s managers, and the Van Depoele Electric Manufacturing Co. of Chicago has been added to the list already embraced by the American Electric Railway Co. It is also reported that Magnus Volk, proprietor of the Marine Electric Railway at Brighton, England, has applied for admission into the association. He is very confident that electric power will be successful as applied to our elevated railroad system.

The Daft company is already engaged in preparing the Brooklyn bridge railway for a trial of its electric motors. The experimental trips will be made without interfering with the existing cable arrangements. Electricity will gain some prestige on the bridge railway if not elsewhere, as the cable system has had the reputation of failing several times when it was most urgently needed. While the electric railway is a novelty it will certainly attract a large number of passengers who might otherwise go elsewhere. Its use may therefore be looked for in connection with the vast excursion traffic to the beaches during the summer. A survey has already been completed for an electric railway between Far Rockaway and Rockaway beach. The total length of the road will be a little more than 5 miles. The rails will be laid on an iron superstructure similar to that of the elevated railways in this city. It is expected that the contracts for building the road will be made within a few days, and work commenced immediately afterward, as it is intended to open it for travel on July 4 next. The projectors recently filed articles of incorporation in Albany and Jamaica for the Rockaway Electrical Railroad Co., with a paid up capital of $200,000. It has already been reported that the introduction of electric motors will be opposed by the Brotherhood of Locomotive Engineers, but their advent will doubtless be welcomed by the stationary engineers, At all events the success of the system will depend on its merits, and the suspension of traffic for a few days on the short elevated railways, where other means of transportation exist, would not be a very serious matter to the public.

The high wind which visited this city on the 17th was unusually severe in its effects on the telegraph lines throughout the country. In New York it presented renewed arguments for placing the wires underground. By a cross between an electric light and a city fire alarm wire, a dynamic current was conveyed to Fire Hall, which started a small conflagration and for a moment threatened disaster to the entire apparatus at headquarters. Of course active measures were at once taken to extinguish the flames, which were so immediately successful that the damage was not serious. The insulation on some of the electric light wires must be nearly worthless, and with the prospect in view of being forced to place their wires underground, it can scarcely be expected that their owners will incur any expense in their maintenance which can possibly be postponed.

Brooklyn is the only place in the state outside of this city to which the underground telegraph bill is applicable. Both of these cities have had their borrowing authority cut off by a recent constitutional amendment, and are now confronted with the unusual expense of burying the municipal wires as required by law. Mayor Low in his annual message was very decided in his opinion of the underground bill, as is shown by the following extract:

> The Underground Telegraph law, so called, of last session has been a great embarrassment to the city. Its only known effects thus far, excepting a slight experiment with underground wires by the telephone company in the neighborhood of the City Hall, have been to prevent the city from securing $5,000 worth of telephone service per annum free of cost, and to prevent in a number of instances, the extension of the fire alarm telegraph system. The effect of the law is wholly negative. It does not provide a single positive direction or method as to the accomplishment of the end which it enjoins. I am clearly of the opinion that Brooklyn ought to be exempted from its provisions unless at the ensuing session of the Legislature it can be made a practicable measure.

The receivers of the Bankers and Merchants' Telegraph Co., are still pulling hard against the rapids. They have effected settlements with some of the larger creditors of the company, partly on a basis of 60 cents on the dollar, while others were paid in receiver's certificates having two years to run. The employés are paid in driblets. The Baltimore and Ohio company is continually adding to its working force. The recent acquisition of D. J. Ludwig and some of his assistants from the Commercial News Department of the Western Union company, points to the organization of a similar service by the new company. A system of quotation printers will also be added. Mr. W. F. Coffee is actively engaged in preparations for starting a quotation system using the Woershing printer. The failure of the Gold and Stock Telegraph Co. in its efforts to obtain an injunction against the Commercial Telegram Co., will allow the latter to continue in its vigorous competition for this lucrative branch of the telegraph business. The Gold and Stock company will soon be in the field with an equipment of Scott printers, which it is expected will enable it to keep abreast with the transactions of the stock exchange during the most active market. The new instruments will be operated by dynamic electricity, and the estimated cost of the change is over $100,000. It is believed that this expenditure will however place the company so far in advance of its rivals, that it will be secure in its practical monopoly of the business for many years.

It is reported that the New York Steam Heating Co. has offered the government a rental of $10,000 per year each, for the basements of the Custom House and Post-office buildings in which to locate plants, probably for electric lighting. It offers to light and heat the buildings in addition to the rental. This service now costs the government about $80,000 annually. It is understood that the supervising architect will report unfavorably to the proposition, on the ground that the government is likely to need the space, and also that it would be an improper precedent to allow private parties to obtain such a foothold on the premises named. If this attempt fails it will doubtless be renewed after the coming administration takes charge of affairs. There is a demand for more electric lights down town than the Edison company can furnish, and since the reduction in the price of gas from $2.25 to $1.75 per 1,000 feet, there has been a general complaint that the quality of the gas has so deteriorated that there is really no benefit to the consumer.

J. H. Bunnell & Co. have removed to the south-west corner of Liberty and New Church streets, a few doors east of their old stand No. 112 Liberty street. The new store runs through from Liberty to Cedar street, while half of the frontage on New Church is of glass, making a salesroom exceedingly light and convenient. The location is quite a prominent one, and the change will no doubt prove beneficial to this young and enterprising firm.

Electricity has been recently identified with several incidents, which have brought the participants into the hands of the police. A young man who was discharged from a lumber yard in Brooklyn recently, made his old employers happy for a time, by telephoning orders from different customers for lumber to be delivered at various places. His scheme was discovered, and the boom in the lumber business terminated before he had made any sales.

Just before the holidays John Cunningham and John Burns wearing the uniforms of Western Union messengers, and fortified by a "New Year's greeting" under the guise of poetry, visited various down town merchants and brokers, and collected $820, which it was supposed they were to divide with their comrades. The fraud was discovered and the two bogus messengers were convicted of petit larceny, and sent to the penitentiary for one year.

John H. Davis & Co. called a messenger from the Independent Messenger Co., which does business for the Stock Exchange. The call was answered by W. H. Devlin, who took $1,365 in coupons to the Merchant's Exchange National Bank to be cashed. Contrary to ordinary business usage the coupons were paid in greenbacks instead of a check, and the boy failed to return. A detective was put on his track, and he was finally intercepted at Syracuse on his way to Montreal, and $1,050 recovered, also $266 which he had left with a comrade in this city.

The burglar alarm apparatus of a well-known Paterson manufacturer, living in Broadway, refused to work, and an electrician was sent for. He found that some one had removed the battery from the shelf in the cellar where it had been placed. The cook, being consulted, explained that she had found the jars and washed them out, as the sweetmeats were all spoiled and mouldy. Then she proudly pointed to the missing battery jars, as bright as new dollars, on the kitchen shelf with the fruit jars.

New York, Jan. 25, 1885.

CHICAGO.

How Fires in Theatres are to be Promptly Extinguished.—Tests of Various Insulated Wires.—Who was the Original Inventor of the Storage Battery?—The Chicago Driving Park Not Yet Lighted by Electricity.—Telephone Dividends Payable on Sunday.—The Van Depoele Electric Manufacturing Co.—Electric Light Interests Awaiting Action of the City Council.—Cut-throat Telegraph Rates.

My attention has lately been called to an electrical arrangement for theatres, public halls and the like, where, from the inflammable nature of the scenery and stage appurtenances a conflagration, with all its concomitant horrors, is ever possible. The inventor is a Philadelphia gentleman, whose name figures quite extensively in the patent office reports of the past few years. In the office of the chief of the fire department this gentleman, Mr. W. C. Shafer, has placed a complete working model of a theatre, with a very pretty little stage set, the curtain up and all as if a

play were being enacted before an audience. After a full explanation of the *modus operandi* of the apparatus, he touches a match to a string, which burns, of course. Down drops the curtain by the run, a trap door in the roof opens over the stage, an unexpected deluge of water falls, the auditorium doors fly open, and the audience presumably make their exit before having hardly smelled the smoke of the burning, while, as they emerge, they see in the foreground of the out-door picture the representatives of the fire department at full gallop in response to the thermostat alarm. The whole apparatus is ingenious and quite complete in all its connections and arrangements. In practice the curtain is of asbestos cloth, on a wire netting. By means of a weight of 700 pounds, and a combination of gearing, this is held suspended by a mere string, and when released will drop about 34 feet in six seconds. During the first foot of this descent it rings an alarm bell to the actors, who clear the line of its drop; or, its machinery may be discharged by means of a thermostat, in lieu of the burning string. In case of an accidental release of the curtain a cord at the prompter's side of the stage governs a break, which perfectly controls the falling curtain at any point in its descent. The battery used is normally closed, and a magnet in the circuit notifies the party in charge by ringing a bell through a local circuit when the current of the main battery is weakening, but before this has so far failed as to let go the sustaining magnet. If the combination will work as well in practice as in the model it certainly looks like a valuable adjunct—for very little expense —to the show business.

Insulated wire for underground purposes still holds its own as a topic of interest. Samples are constantly making their appearance here, and hardly a week passes without a test—and these are crucial—in the city electrician's department. Some months since I chronicled a test which was far from satisfactory on a sample of one of these, a much advertised and much endorsed wire, nearly a quarter of a mile long. A second sample of the same wire was recently made and sent here which was even worse than the first, giving less than one-half the insulation resistance. On the other hand a sample of wire 350 feet in length, cased in a copper plated hard rubber tube, was coiled in a large tank of water for several days, and during the last three days of the immersion 8 tests were made at intervals of several hours. These tests invariably showed the same result—3,000 *meghoms to the mile!*

A sample of wire insulated with gum copal dissolved in castor oil, cotton wrapped, showed absolutely no value after a limited immersion. Nor was this the result of a leak from some single point—for when after removal from the tank it was laid upon the floor, the general leak was made apparent whenever a ground connection was made with its damp outer covering at any point. It is but fair, however, to state that the wrapping was poorly done, and the whole sample reminded one of the musical expert's remark on a new song handed him for criticism. "It looks as if somebody had made it himself."

In an article on storage batteries (O. J. L., in *Nature*), in the January number of your journal, Faure is credited with the invention of the storage battery. I had the impression that Gaston Planté was the original inventor, or at least, was before Faure. Faure claimed originality for the invention, and this was controverted in the "Société d'encouragement," in 1881, by Emile Reynier, in favor of Planté. The late Comte du Moncel, at that time in an editorial on the preposterous claim, said: "We would like to know where is the originality in this invention of M. Faure. Does he employ other electrodes than M. Planté? Is the effect produced by electrolysis in his battery different from that produced in the Planté? Is there not always a film of peroxyde of lead formed at the positive electrode? In principle, in materials used, in form, and in results obtained, there is absolutely nothing new in the Faure battery," etc. Still, the old saw, "a lie will travel from Maine to the Rocky Mountains while truth is pulling on his boots," will continue as trite and applicable as ever, while Drawbaughs and Faures cumber the ground. A prominent Chicago inventor's definition of a patent claim comes to mind in such cases. One fellow invents a coffee pot. Another changes the places of the spout and handle, and claims this as a new invention; "because, don't you see, neither the spout nor the handle are on the same side as in the other, and besides, mine was the original invention, anyhow."

How often it is necessary to go abroad for home news. One of your electrical contemporaries in a review of electrical events and progress in 1884, mentions that "at Chicago an installation was made of 330 arc lamps to light up a new driving park," etc. When someone was "making" a dictionary, he submitted a definition to a lexicographer for criticism. "Crab—a fish, of red color, which swims backward." "Correct, except in three particulars. A crab is not a fish, it is not red, and it does not swim backward," was the criticism. Three hundred and thirty lamps were not installed in a new driving park; there was no installation except in an old driving park, which consisted of but 10 arc lights; this plant was only for a special occasion, and remained but four days.

The Chicago Driving Park is to be lighted next year, with 230 Western Electric lamps and 100 Excelsior lamps, which will be inaugurated on June 6th. The machines for this plant are being constructed, and poles will be set as early in the spring as the settling of the ground will permit.

The Wisconsin Telephone company paid a quarterly dividend last week of 2 per cent., making their tenth. The Chicago company has also divided with the holders, and the Central Union has declared a quarterly 1½ per cent., payable on the 25th. Let's see; what day of the week did you say that would be?

The Van Depoele company has reorganized and is now the Van Depoele Electric Manufacturing Co. I was at their shop a day or two since, and while they complain like all the companies of hard times, they are as busy as nailers on lamps and motors. One of these of 50-h. p., is being built for railway service, and as this company is one of the many in "The American Electric Railway Co." consolidation, it will probably make its *debut* among those to be tried on the Second avenue elevated road in your city. Mr. Van Depoele has introduced in this, as he believes, some new and peculiar combinations which will give important results. I am not at liberty to mention details, but may say in general that, judging from results obtained in the performance of a 20-h. p. motor, in running the machinery and elevator of the shop, he has good foundation for his belief.

The electric light companies as a rule are comparatively at a standstill for a time. The petition of sundry citizens to the city council, asking permission to hang outside lights has not yet culminated in anything save delay, and of course it is impossible to foretell what the outcome will be. I honestly think, however, that all will yet be satisfactorily arranged, and that work will soon resume its former activity.

The B. & O. Telegraph Co.'s cut in rates was rather a surprise, but the business of the other companies seems little affected by it, to judge from the standpoint of an outsider. It will undoubtedly increase the amount in gross of telegrams sent, for the rates are now so low that one can often better afford to telegraph than wait for the fastest mail.

CHICAGO, Jan. 15, 1885.

PHILADELPHIA.

An Era of Litigation.—The Telegraph Companies object to the Pole License Fee.—The Referee Decides that the Fees are Unreasonable.—Judge Biddle's Decision in the Local Electric Light Suit.—Plans of the American Telegraph and Telephone Co.

THE Referee appointed by the Court in the suits of the city against the Western Union and Mutual Union Telegraph companies and the Bell Telephone Co. has filed his report, in which he finds for the defendants in every case.

The ordinance of 1881 provides that "no pole shall be erected without the license of the Superintendent of the Police and Fire Alarm Telegraph shall have been obtained therefor, and for every license so granted shall be paid to the city treasurer, for the use of the city, the sum of $5 per pole." Further, it says that application shall be made for continuing the license for the ensuing year, and the charge for such license shall be $1 for each pole. The ordinance of 1883 says: "On all conductors or wires suspended above ground, except such as are used or owned by the city of Philadelphia, an annual payment of $2.50 per mile, or part thereof, in length of wires or conductors, shall be paid for each and every wire or conductor used or to be used for telegraphic, telephonic, or other purposes." "Failure to make payment as required thereby shall subject the offender to the penalty of $50 per month for each and every day thereafter until payment is made."

The actions were brought to recover the license fees and a penalty said to have been incurred by the Bell Telephone Co.

The defendants filed answer, claiming that the municipality had no power to enforce ordinances; that the fees are unreasonable and amount to a revenue; that they exceed the rate of taxation on other property, and operate in restraint to trade, and that the companies had paid state tax on the poles and wires.

The fees claimed amount to $6,885. The Referee's report says: "If the exaction of a license in any case is simply a means, in good faith, of enforcing reasonable police regulations, then such exaction is a *legitimate* use of the power to regulate. If it is an attempt to tax, then it is an abuse.

"I conclude, therefore, that the city has a right to exact reasonable license fees for the erection and maintenance of poles and wires, and the question then is whether the fees sought to be charged by the ordinances of 1881 and 1883 are reasonable, which brings us to the third question discussed before me.

"I am of the opinion that the license fees required by these ordinances are not reasonable, and are, therefore, not within the proper powers of the police regulation possessed by the city. They are in effect an attempt to impose a tax, which the city has no right to do.

"That the fees are unreasonable seems to me to be apparent from the undisputed facts of the case. The total cost of maintaining the whole system of police and fire alarm telegraph is about $25,000. Of this, only 10 per cent., or $25,000 at the most, is chargeable to the expense of supervising the erection and maintenance of poles and wires by telegraph and telephone companies. License fees which would aggregate only $2,500, or perhaps $3,500, would be a reasonable exercise of the power of regulation. License fees of which the total amounts to 50 per cent. of the whole expenses of carrying on the depart-

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ment are, to my mind, in the nature of tax. This view seems to be strengthened by comparing the amount paid with the value of the property. The cost of erecting poles and wires in the city is, according to the evidence, in the neighborhood of $500 per mile. This is estimating 40 poles per mile. The tax in such case would be something over $40; in other words, nearly 10 per cent. of the value of the property. If it be said that the value of the poles and wires is no criterion as to the value of the property, the property being really the franchise to erect poles and stretch wires, the answer is that the corporations already pay tax on their capital stock, and that there would seem to be no authority on the part of the City of Philadelphia to do something which would practically amount to levying a tax upon the corporate franchise.

"For this reason, therefore, namely, because the license fees exacted are unreasonable as fees, and because they operate in substance as a tax, I am of opinion that the ordinance cannot be enforced, and that the finding in each of these cases should be for the defendants, and I accordingly so find."

Judge Biddle recently delivered an important decision sustaining a demurrer filed by the Underground Electric Light and Power Co., in the suit brought against that corporation by the electric light company which operates the Brush system. The latter company was incorporated under the general incorporation law of 1874, under the 34th section of which they claimed to have the exclusive right to supply electric light to this city until they had for five years declared dividends equal to 8 per cent on their capital stock. They asked that the Underground company should be enjoined from violating their exclusive right, such profits not having as yet been realized. Judge Biddle first remarks that, before a claim of this magnitude can be allowed, a court of equity must be entirely satisfied that it was the clear intent and meaning of the law, under which the right is claimed, and that all the provisions of the law have been strictly complied with, and then discusses the several provisions of the act and the best settled rules of statutory interpretation. He then says: "The complainants having failed to satisfy us that they have received the lawful consent of the authorities to erect their works in the city, the demurrer in this case is sustained.

The gentlemen interested in the American Telegraph and Telephone Co. have received word from Harrisburg that the charter they applied for some time ago had been duly granted. This company proposes to run lines from Philadelphia to Easton and Pittsburg, and ultimately to extend its operations to all the principal cities and towns of the state. The incorporators are Messrs. J. E. Kingsley, Samuel B. Huey, Josiah R. Adams and F. E. Buchler, of Philadelphia, and Thomas B. Doolittle, of Boston. This company will use the Bell system.

PHILADELPHIA, Jan. 16, 1885.

BOSTON.

Mysterious Manifestations of Massachusetts Mayors' Master Minds.—What Boston Deems a Big Fire Turnout.—Patent Litigation Between Electric Light Companies.—The Western Union Puts 30 Wires Underground.—Organization of the Boston Telegraphers.—The Electric Light Consolidation Still in Abeyance.—An Electric Ship's Log Register.—Calling a Cab and Catching a "Cop."—Improvements in the Fire Alarm System.—The Electrical Exhibition and its Attractions.—A New Blake Transmitter.—The B. & O. Telegraph Co. Loses its Telephone Service at New Bedford.

IT has been interesting to observe the workings of the various great minds inaugurated as mayors of the cities in this vicinity, so far as they grasp the electrical problems before them. The mayor of Boston speaks highly of the electric light, and figures out economy in the present system of lighting. The mayor of Lowell recommends that some of the electric lights be discontinued; and in consequence of his remarks that the police telegraph, which has been in use in that city, was unnecessary, impracticable and unauthorized, it has been taken out. The mayor of Newton recommends that the school houses be provided with private fire alarm signal boxes. At Haverhill his honor suggests the use of a 5-circuit repeater in connection with the fire alarm. The new mayor of Worcester advises putting in more electric lights. In Springfield the newly-elected recommends the adoption of a police and telephone system.

An alarm from box 746, December 29, brought to Jordan & Marsh's extensive dry goods house 7 steamers, 3 ladder trucks, 2 chemicals, the water tower, aerial ladder and Hayes truck, and, in the words of one of the engineers, "it was the best turnout the department has made in 20 years, every piece of apparatus being promptly on hand." No. 746 is one of the 14 special boxes located in hospitals, theatres, public buildings and large dry goods stores, and each one calls for a large number of pieces of apparatus on the first alarm. An immense crowd of people swarmed to the scene, but fortunately nothing was burned of any account. Fifty dollars will cover the fire damage, although the smoke may have caused more.

The United States Electric Light Co. have commenced suit against the Thomson-Houston Electric Light Co., of Connecticut, having its factory at Lynn, Mass.; the American Electric Illuminating Co., and the Merchants' Electric Light & Power Co., of this city, for the alleged infringement of an important patent connected with the electric light. The New England-Weston Electric Light Co. is a party in the suits against the last two named companies. A permanent injunction is asked for. The infringement alleged is on E. Weston's patent—234,443, November 16, 1880—on a ventilated armature for dynamo machines. The Thomson-Houston company defends the suits.

On January 1st the Western Union switched 30 of their overhead wires into their new underground system, through to Friend street, and have them now all in use. They work very well. The unsightly poles, over which there has been so much agitation, will now come down and be made useful in some other place or capacity.

On the afternoon of January 4th the telegraphers held a meeting at Young's Hotel. Officers were elected and a complete organization was perfected, but the names are not made public. The name is "Boston Council, Telegraphers' Protective Union," with an enrolled membership of 60 members, from all the telegraph companies of the city.

The consolidation of the local electric light companies does not as yet come off. Committees have been appointed from two of them to consult, but at last accounts they had not met very unanimously. There are always to be found people who are willing to consolidate and unite to divide the profits with those stronger and more prosperous than themselves.

A new and simple electric ship's log has been on exhibition in Gloucester, the invention of two young men of that place. The object of the invention is to register, by means of an electric current on board of sail or steam vessels, the number of miles traversed through the water. The flange spindle has a projected point, and at each revolution of the propeller the projecting point touches the spring on the diaphragm, presses it against a cable wire and closes the circuit. On board the ship is placed a register, and when a mile has been made the figure 1 appears on its face. With the use of this log the register can be taken without raising the log from the water.

The necessity of making proper connections was aptly illustrated one evening recently as a gentleman, late in the evening, sauntered into a district box cubby to have a herdic called to take him to the railroad station. The boy in charge gave the wrong call, and summoned the police. Meanwhile the gentleman, seizing his gripsack, sauntered out. In came the "cop" with a boy. The "district boxoneer" told the boy he would find the passenger down the sidewalk, describing him, etc. Soon the passenger, struggling in the hands of the "bobbie," returns, the latter inquiring what offense the former had committed. Mutual and triple explanations ensue. By this time it's too late for the train, and the passenger retires to a hotel to dis-*cuss* the district system.

The fire alarm office at the City Hall has been improved in many ways within a few weeks. A number of new receiving and transmitting instruments have been placed in position. To provide for the gradual increase of the system, as more territory is covered by the fire department, arrangements have been made so that with a few connections alarms can be received from 36 circuits, 21 only now being in use. There are now 365 fire alarm boxes and about 300 miles of wire. As a precaution, in case of the destruction of the fire alarm office by fire, the superintendent has established in various fire department houses a number of batteries, by which, in a very short time, a complete fire alarm system would be in operation throughout the city.

The Electrical Exhibition is still offered to the public as a means of entertainment and amusement. It is a very pleasant place to pass an evening. The exhibits are mainly of a kind to mildly instruct and please the popular mind. As a technical electrical exhibition it has no claim, but there is variety enough in the exhibits to draw that floating portion of the people who want to go somewhere. The daily papers have been kind in their notices, and each new arrival has been duly mentioned. Thos. A. Edison has been a frequent visitor. As he is a prominent exhibitor, his anticipated presence has always been announced, and he has in fact been made an attraction. To his and Mr. Ezra T. Gilliland's efforts what success the exhibition has had is largely due. Edison has a pretty show of incandescent lamps, sections of his underground wires, quadruplex and telegraph apparatus. The phonograph has been an attraction. The Oram telephone time repeater is in charge of the *Electrical Review* company. The Weston company show very handsome clusters of lamps. "Easy Lessons in Electricity" is being printed on a press run from a Weston dynamo; Kettell's clock regulating system is shown. The blind carver works behind a bench; what circuit he is on does not appear. Devices for utilizing wave power are explained by a young woman; this is *not* the Vienna or any other hair wave. Gear cutting machines and castings abound. Blodgett Bros. exhibit as a part of their admirable show the engine and dynamo recovered from the wreck of the "City of Columbus." The Jerome Redding company have a good exhibit; their watchman's register, with type-writer card, is something new. Washburn & Moen have an exhibition of wire of all kinds. At this "electrical" exhibition one can buy all kinds of ivory articles; Waterbury watches; a convenient kerosene fixture; rubber stamps, of which the rubber is vulcanized, heated, etc., by "electric" heat. The attendance has been small, and not much interest has been shown by the exhibitors. In most cases

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no one is in attendance to explain the exhibits, and of those who *are* on hand, unless they have something to sell, they gaze at one with a stony, glassy stare.

Mr. Francis Blake, as the journals have announced, has invented what he calls a "new Blake transmitter." He has made a great many experiments with it, in various forms, and yet no one knows what it is, excepting his patent solicitor. Mr. Blake has a laboratory and workshop at his residence in Weston, Massachusetts, and makes all of his models and experiments with his own hands. I had the pleasure of listening to the new transmitter, Mr. Blake speaking from Weston to Boston, a distance of about 15 miles. The transmission was loud and the articulation remarkably clear.

The Southern Massachusetts Telephone Co., on the 15th inst., endeavored to remove their instruments from the Baltimore and Ohio Telegraph office at New Bedford, and were resisted, as the service had been paid for in advance. The telephone company has ordered its operators not to respond to the calls of the B. & O. Telegraph Co. A war appears to be in prospect.

BOSTON, Jan. 17, 1885.

WASHINGTON.

Mr. Money's Postal Telegraph Bill Goes Over Four Weeks.—A Grand Electric Lighting Scheme Probably Killed.—Installation of Incandescent Lamps by the U. S. Company.—Extension of Electric Street Lighting.—Successful Working of the Various Subterranean Wires.—An Experimental Exhibition of a New Electric Lamp.—Weston Lamps for the Washington Monument.

MR. MONEY, Chairman of the House Committee on Post-offices and Post-roads, had indulged in a faint hope that his committee would be reached Jan. 19 under the rule permitting suspension of the rules for action upon the Postal Telegraph bill, but the day was spent on obstructions thrown in the way of the passage of the bill to place Gen. Grant on the retired list, and with the day went Mr. Money's chances for the next four weeks, and probably for the session, as the appropriation bills will probably interfere with another effort as late as the 16th of February. It is not likely that the bill would have received the necessary two-thirds vote, but it would have been interesting to have seen how the House stood upon the question. With this goes almost the possibility of legislation on the telegraph by this Congress, and its prospects for the next are not much brighter unless it is made an Administration measure, which is in no wise likely.

In April last Mr. Cosgrove introduced in the House a bill "To authorize the lighting of the navigable waters of the U. S. with electricity." The bill authorized O. W. Childs and his associates "to acquire, hold and own" suitable stations and to erect and use suitable appliances therefor, with the right to enter into contract with and receive pay from those who desire the use or who may be benefited by the system of light adopted. The said Childs and associates were to be permitted to establish such system of transmitting intelligence as they might deem proper in connection with said system of electric lighting. The bill went to the Committee on Commerce and comes back somewhat circumscribed; the substitute simply authorizing the construction at their own expense of the necessary building rafts or other structures for the purpose of experimenting in electric lighting, providing such structures shall not interfere with navigation, and after plans, specifications and drawings have been submitted to and approved by the Secretary of War. This bill will probably go, with several thousand others, into the waste basket, March 4th.

The incandescent lamps for the branch of the government printing office located in the sub-basement of the Treasury building, by the United States Electric Light Co., were lighted on Wednesday last and prove highly satisfactory. The location is such that the ventilation is very imperfect, and the substitution of electricity for gas is warmly welcomed by the employés. The same company will in a few days place a number of the 125 c. p. lamps of the Weston patent on the upper floors of the Treasury building. It is proposed to place 200 incandescent lamps of this company in the Interior Department, as soon as the wires can be run.

The street lighting by the United States company on F street has proved so satisfactory that, encouraged by the business men on 9th street, they have applied for and been granted permission to light that street from F street to Pennsylvania avenue, the authorities paying an amount equal to the contract price for gas, and the merchants benefited paying the difference. Application has been made by the United States and the Brush-Swan companies to light Pennsylvania avenue on the same terms, but as yet neither have received the desired permission. The rivalry between 7th and 9th streets is so great that the former will soon come under the electric system.

The telephone company has recently laid a 100 wire cable from its exchange, New York avenue, between 14th and 15th streets, to the corner of 5th and D streets, a distance of about a mile and a quarter, and the wires are working well. With enough electric light, telegraph, fire alarm and telephone wires underground to make a thorough test, and all working satisfactorily, the district commissioners feel strengthened in their efforts to drive out the overhead wires.

The revived telegraph lines are not likely to crush out their older rivals soon. I hear that the Bankers and Merchants' company have not paid their employés for several months, and that they are getting quite despondent. Manager Cox and his associates have been untiring in their efforts to build up the business, and their zeal deserves a better reward.

Mr. J. Von Gestel has been exhibiting a new electric lamp of his invention in the basement of the Capitol for a few days past. His light is produced by a very small carbon in contact with a copper rod—a semi-arc light—with a short bar of compressed and baked magnesia resting above the point of contact. This, he claims, absorbs the heat and prevents the consumption of the carbon, while the magnesia becomes incandescent, throwing out a brilliant light. His experimental lamp is crudely made and not well balanced in the several parts of its mechanism, and has not yet reached the maximum claimed for it, but gives good promise of doing so. Further tests are to be made.

The Edison people have been invited to substitute their lamps for gas in two of the panels over the Senate chamber, as a test of the two modes of lighting. If the test is satisfactory, they will substitute the incandescent light for gas in all the panels, and probably in the business offices of the Senate before the meeting of Congress in December. The long night sessions incident to the last days of a Congress will afford an excellent opportunity for testing, side by side, the two modes of lighting. It is a question of convenience rather than of economy, and the lamps stand a good chance to win.

The following statement which I noticed in a recent New York daily, is not in accordance with the facts so far as this city is concerned.

Thomas A. Edison, inventor.—A dark day, yes, but all those clouds have a silver lining for me. How is that? Well you see on days like this the out-turn of light in the down-town central station is about doubled and our receipts are correspondingly increased. Busy? Never more so. I have got out a new batch of telephone improvements. They think well of them in Boston. You have heard I suppose that the light company has just signed a contract with Colonel Casey, the chief engineer of the Washington Monument, to light the interior with 125 lamps. That puts the electric light 550 feet in the air, considerably higher than we ever expected to get when we hung the first lamp on a telegraph pole in Menlo Park a few years back.

On January 24 at 12 o'clock the bids for lighting the Washington monument by electricity were opened, and the contract awarded to the United States Electric Lighting Co. of this city for $1,972, being $28 below the Brush-Swan, and $628 less than the Edison, offers. The specification calls for an incandescent dynamo, of not less than 150 lamp capacity, 75 lamps and appurtenances, to be ready for service on Feb. 21, when the dedication is to take place.

The sleet storm of January 23d prostrated telegraph and telephone wires in every direction. The occasion was taken advantage of by President Waring of the Standard Underground Cable Co., who availed himself of nature's protest against overhead wires, to advance the interests of his cables in government circles on the following day.

WASHINGTON, D. C., Jan. 26, 1885.

NEW ORLEANS.

Incomplete State of Electric Light Plants.—The Edison Company's Installation a Great Success.—What the Other Companies are Doing.—Improvements in the New Orleans Telephone Service.—The Louisiana Time Telegraph Co.—The National Improved Telephone Co.—The Coming Electric Railway.

NOTWITHSTANDING all the efforts in that direction, the several plants for lighting the exposition grounds and buildings are not entirely in readiness as yet. The Edison company is in advance of the others, inasmuch as its plant in the main building was completed some time since, and has been running without interruption. This, they claim, is the largest isolated plant that has ever been erected—capacity over 5,000 lamps. From its unique design it is called the "Fort Edison Battery." Six engines are placed as the spokes of a wheel, and the 12 dynamos (400 ampère machines) driven by them, surround them in a circle. Two thousand lamps are placed in Music Hall and its approaches. Conspicuous in the former are the 5 beautiful clusters of 70 lamps each, suspended along the centre of the dome. The various offices in the building and its entrances require 1,000 more, and the art gallery, 2,000 feet away, is wired for another thousand. Besides these, the Furniture Pavilion of the Grand Rapids company will use a considerable number. In the government building a 1,500-light plant is being put in, the wires having already been distributed to the offices located therein.

The Louisiana Electric Light and Power Co., are putting in 35 30-light Excelsior machines, of which a number have been

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running for a month or more. Their contract calls for 800 standard arc lamps for the interior of the main building, which they say is the largest of like character ever made. They will also furnish lamps to any exhibitors who may need them. A 36,000 candle-lamp, will probably be placed in each of the 5 entrances to this building.

The Jenney Co., have 5 Star towers within the grounds, upon each of which are 10 lamps.

The Thomson-Houston Co., illuminate Horticultural Hall.

The government building (excepting the offices lighted by the Edison Co.) is contracted for by the South-western Brush Co., but has not yet been thrown open to the public at night.

Last spring The Great Southern Telephone Co., succeeded the Louisiana Bell Co., to the business of this city, and since then a great change has been made in the systems. All wires were transferred from house-tops to poles, a new and more suitable exchange building was moved into, and affairs generally greatly improved. Lately a new multiple board of the Western Electric Co. has been put in, the connections being changed to it in 45 minutes. Over 1200 subscribers are on the books and more coming in. Connecting lines are in operation along the river as far as Port Allen—140 miles. A line to Baton Rouge is now being built of No. 14 hard-drawn copper wire from the Ansonia Co. Other lines radiating in nearly all directions from the city, are either built or under way, upon several of which 14 copper wire is used, when these are all completed, this section of the country will certainly enjoy unsurpassed telephonic facilities. In the main building of the exposition, a branch exchange has been established, which can accommodate 300 subscribers. This is connected by trunk lines with the city exchange. The Great Southern, does not appear to fear the coming of rival companies into the field, of which so far it has enjoyed the monopoly. Its general office has been transferred from Nashville to this city.

The Louisiana Time Telegraph Co. is trying to get a foothold among our people, and perhaps in *time* it will succeed, at any rate it will have a good many subscribers for a few months, as the company will put in clocks, *gratis*, for that period; hoping that at the end of that time, they will make a ten strike and wring out the necessary "shekels" for a continuance of the service. Some 200 clocks are placed on the 4 circuits already established.

The National Improved Telephone Co., recently organized and chartered under the laws of this state, propose to compete with the Great Southern for the business of this city. They have licensed the Crescent City Co, who have 1,000 poles on the way, and who are going right to work. They use instruments patented by Chas. A. Randall and T. J. Perrin, and for a switch board use the Perrin multiple exchange system, also the McTighe receiver. This company has an exchange in the centre of main building, connecting the various exposition offices upon the grounds with each other and with those in the city.

An electric railway will soon be ready upon the grounds. The track is completed, and the Daft motor is expected daily.

NEW ORLEANS, Jan. 13, 1885.

ELECTRICAL NEWS AND NOTES.

THE DECISION IN THE CANADIAN TELEPHONE CASE.[1]

On January 24, 1885, the Hon. J. H. Pope, Minister of Agriculture and Commissioner of Patents, rendered a decision in the Toronto Telephone Manufacturing Company vs. The Bell Telephone Company of Canada. This is a case of dispute raised against the existence of Patent No. 7,789, granted the 22d of August, 1877, to Alexander Graham Bell, and now owned by the Bell Telephone Company of Canada, for alleged forfeiture on the ground of non-manufacturing and of importing, in the terms of Section 28 of "The Patent Act of 1872." Messrs. Roaf, McLean, White and Johnson were counsel for the disputants, and Messrs. Hector Cameron, Dalton McCarthy, Dr. McMichael, Hon. Wm. Macdougall, Z. A. Lash and S. G. Wood for the respondents. The petition addressed to the Minister of Agriculture (bearing date 2d September, 1884) by the disputants, represented that patent No. 7,789 is null and void, and should be so declared, for non-compliance with the provisions of the 28th section of the Patent Act of 1872, requiring manufacturing within two years and forbidding importation after twelve months.

THE MINISTER'S DECISION.

The following is the full text of the decision:—This case is the second which has come before this tribunal. It happens that both cases concern interests of vast magnitude, a circumstance which contributed to enhance the sense of the heavy responsibility imposed by the law on me as the Minister of Agriculture, or on my Deputy, in this respect. The first case—*Barter* vs. *Smith*—was tried before Mr. Tache in November, 1876, and his judgment was rendered in February, 1877. I have to refer to that judgment, because it has been made the basis of argument by the learned counsel on both sides in this case, because it constitutes the declaratory law of the country on points raised by the application of the 28th section of the Patent Act of 1872, being in matter of doctrine and of legal interpretation unquestionably correct; and endorsed, as remarked by Mr. Cameron, by the highest judicial authorities, namely, the Court of Appeals of Ontario, the Supreme Court, and, in relation to this present case, by Mr. Justice Osler in his judgment rejecting an application for a writ of prohibition. This tribunal is, therefore, bound to attach great weight to the doctrine and rules of interpretation laid down in that judgment of the Deputy Minister, which judgment embodies the jurisprudence adopted in Canada, when dealing with that section of the Patent Act.

The feature of Patent No. 7,789, granted for what is known under the name of "Bell's system of telephony," is peculiar in so far as it consists both of a process of art and of a portion of the machinery necessary to carry the art into practice. The two elements are inseparable; the electric circuit and the two instruments are the means of giving a practical and tangible shape to the "Bell's system of telephony." Moreover, the instruments, described in the specification and illustrated in the drawings of the patent, are the mechanical contrivances which distinguish this invention from other methods of getting at a similar result. All the elements of which these instruments are composed are of the public domain, and public are also the means of erecting an electric circuit, therefore, the patent is a patent for a new and useful combination of old elements, to obtain an object known beforehand. The combination is the invention, and consequently the subject matter of the patent and mechanism of which it is constituted are new articles of manufacture. The doctrine, universally admitted, of the patentability of a variety of combinations of the same elements for the same object, has been clearly laid down by the Supreme Court in *Smith* vs. *Goldie*. What is patentable is the subject of a privilege, and, in Canada, submitted to the conditions of section 28 of the Patent Act. This patent, like every other patent granted, is, therefore, under the obligations exacted from all patentees by section 28 of the Patent Act of 1872, and subject to the adjudication of this tribunal, should disputes arise as to whether it has or has not become null and void under the provisions of this section. The patent was granted on the 22d of August, 1877, to Mr. Alexander Graham Bell and is now, through a series of assignments, the property of "The Bell Telephone Company of Canada," the respondents in this case. It must be remarked that it matters not who the owners are for the time being, or were at any time; it is the patent which stands before me, as the Minister of Agriculture, to be adjudicated on, not the owners. The patent does so stand with the uninterrupted privileges as well as with the uninterrupted obligations attached to it. This tribunal has not to investigate the *locus standi* of disputants nor of respondents, nor in relation to companies, to inquire whether they are legally incorporated or not; such questions are not within its jurisdiction, and, besides, are quite indifferent to the issue in such cases. When this tribunal is made aware that disputes are raised, in accordance with the provisions of the 28th section, by some person who undertakes to prove his allegations, it immediately becomes the duty of the judges of such disputes to investigate the matter.

In the interest of public rights, if the policy of the law has not been carried out, or in the interest of patent rights if the obligations have been fulfilled, I, as Minister of Agriculture, have not to undertake to initiate cases of disputes, but I must take notice of all cases brought before me in a formal way. The first allegations of the petitioners in this case are that illegal importations have been made of the patented articles, after twelve months from the date of the patent, specifically in the latter days of August, 1878, in January, 1879, and during the years 1880 and 1881. The facts of the first alleged act of illegal importation are as follows:—During the first year of the existence of the patent, the patentee or his representatives in Canada had contracted with Mr. Charles Williams of Boston, in the United States, for one thousand telephones to be delivered within the twelve months allowed by law for importing the invention. At the expiration of the twelve months Mr. Williams had not been able to complete his contract, more than half of the number contracted for having not been furnished. Under the misapprehension, created by the date of the registering of the patent (24th August) that twelve months would only expire with the 24th day of August, 1878, Mr. Williams did forward from Boston, on the 23d of the same month, a lot of seventy-five telephones, which in the ordinary course of transit, should have entered Canada on the 24th, but which, owing to some mishap, did actually pass the frontier only a few days after. The circumstances of these facts show that there was no intention to break through the law, and that the importation was not considerable; therefore this case of importation in the latter part of the month of August, 1878, cannot entail the voidance of the patent.

At the same time that no stress is put upon these facts,

1. We are under obligations to Henry Grist, Esq., Solicitor of Patents, of Ottawa, Ont., for his courtesy in forwarding an early official copy of the proceedings and the decision in this important case.

it is nevertheless an occasion to warn patentees in general against the danger of running so close to the expiry of the twelve months as to incur the risk of coming even a day too late with their last importation. This tribunal is a paternal tribunal, the judges of which are the natural protectors of patentees' rights, and, as such, bound to give to the facts the most liberal construction consistent with a compliance with the spirit of the law; but the patentees are the first guardians of their own interests, and should not put their property in jeopardy by placing these judges in the position of being obliged to overstretch leniency in order to save their patents. During the first year of the existence of the patent, then, the patentee, or his legal representatives, imported, or caused to be imported, about five hundred instruments ready for use, as they had a right to do; a few days after the expiration of the twelve months they also imported, or caused to be imported, seventy-five complete instruments, which latter importation being inconsiderable, and apparently done in good faith, and not with any intention to evade the law, is declared not to have forfeited the patent. There remains now to examine what was done after that time. It is desirable, first, to enter into a cursory examination of the instruments patented as new articles of manufacture. It will, however, be sufficient to investigate the elements of one of these two instruments, the one commonly called the "Hand Telephone," represented in figure 6 of the drawings of the patent. It consists :—1st. Of a casing with a side cover, the whole being at the same time a handle, with a flat ring piece fixed to it, called disc in the trade, and a perforated cup-like screwed top; the whole and the four distinct parts of which are of a form special to this new article of manufacture; this handle casing may be made of any suitable materials, but as a matter of fact is in this case made of hard rubber. 2d. Of four bars of magnetized steel, bound together by screws and nuts. 3d. Of two soft iron pieces, called drop forgings. 4th. Of a bobbin, on which silk-covered, small copper wires are rolled around. 5th. Of wire posts, also called screw cups, and a regulating screw. 6th. Of a metallic vibrating plate or diaphragm, sometimes called disc, as a matter of fact cut out and otherwise worked from what are commonly called japanned or ferrotype plates. 7th. Of a few other insignificant articles of construction. It will expedite matters to consider, together, the two questions raised in the dispute of illegal importation and of non-manufacture, for in the measure that illegal importation goes on, in that measure the industry and the labor of the country are deprived of the benefit of manufacturing. Therefore, we have to examine what, in these instruments, is raw material which does not fall under the application of the 28th section, and what are industry and labor, because it is clear that if the aggregate amount of industry and labor entering into the making of such instruments was mere trifling, unless a criminal intention of totally disregarding the law was shown, which is not the case here, it would not be a liberal nor a reasonable interpretation of the spirit of the law to destroy the patent on account of its importation or non-manufacture. If it were, for instance, amounting in all to a value of ten dollars a year, as the learned counsel, Mr. Macdougall, has it, with the Latin maxim—*de minimis non curat lex*—or even if it were ten times as much as that for every year. As already said, it will suffice to confine our study of the case to the examination of one of the two instruments patented—the "Hand Telephone." The raw materials of this instrument comprise steel in bars, soft iron, wood and vulcanized rubber, to which must be added, as common articles of commerce, silk-covered wires, japanned plates or sheets of ferrotype, as some call them, screws, nuts, and maybe wire posts. The value of each hand telephone complete is about $2.00; the value of the raw materials, including common articles of commerce, entering in each instrument, may be said with certainty not to reach the aggregate of $0.90. Therefore the industry and labor put upon each of these instruments may be set down at about $1.10. One would be inclined to take a much more exalted idea of the value of the labor put upon the two instruments patented, from the statement made by Mr. Sise, the general manager of the Bell Telephone Company of Canada, that their telephone factory at Montreal, established in 1882, has $50,000 capital invested in it, and that the pay-roll of that factory amounts to $30,000 a year wages; notwithstanding that the rubber handles of the hand telephone are not yet manufactured in Canada, as we have it from Mr. Sise, who says that they cannot get them made in Canada, having again vainly tried to do so a week before he gave his evidence in this case, which, of course, can only mean that the Bell Telephone Company have not procured for themselves the moulds to manufacture those rubber handles. Although Mr. Sise does not discriminate the work done at their Montreal factory, it is clear that such an amount of yearly wages cannot be exclusively devoted to the making of the two instruments patented in Patent No. 7,789; but the statement, with all its surroundings, proves that the manufacture of the two instruments is not an insignificant trifle, but is, on the contrary, an advantage worth being looked after. There are many thousands of them now in use in Canada, and there were, at least, several thousands when the Montreal factory was started. The question comes then: Has the patentee or his legal representatives imported or caused to be imported, after twelve months of the existence of their patent, the new article of manufacture patented? There cannot be a shadow of doubt that they have so imported or caused to be imported the articles, manufactured in parts, to be simply put together at an amount of labor, at times paid $0.30, at other times $0.27, in Canada. It is, in fact, virtually admitted by them, when pleading that putting together or "assembling" the parts ready made, is construction and manufacture, in the meaning of the law. It is equally evident that, during the same period, that is coming to the year 1882, they have failed to manufacture to the extent that they have imported, and that, from the year 1882 to the date of hearing the evidence of Mr. Sise, the 3d of December, 1884, they had been importing the rubber handles in a manufactured state. The intention, although not malicious, to evade the law, is nevertheless manifest. During that considerable time of the existence of the patent (to 1882) the same foreign manufacturer, Mr. Williams, with whom the patent owners had contracted for one thousand telephones to be delivered during the first twelve months of the life of the patent, and who furnished only about five hundred during that period of time, did continue to send them to Canada for years to supply an ever increasing demand. But to evade the law and give a color to the importation, instead of sending these instruments consigned to the patentee's representatives, he sent them, in pieces to be put together in Canada, to some one through whose intermediary the patentee's representatives received them when "assembled." All this is proved in the clearest manner by Customs papers, by accounts furnished, by declarations from one of the Cowherds, from Mr. Foster, and by correspondence on the subject. We have it from Mr. Sise himself, with some reticence, but also with some details. He explains the reason why this importation and this non-manufacture were resorted to. "Mr. Charles Williams, one of the owners of the patent," says Mr. Sise, "was and is the only manufacturer of Bell telephones in the United States; he is the only man who is licensed by the Bell Telephone Company to manufacture telephones; he is the only manufacturer to-day that I have any knowledge of ... Mr. Charles Williams was the only man who had that knowledge of it, and who had the control of Cowherd's shop....I think we paid Williams, and I think he was the man who employed Cowherd....Mr. Williams having arranged with Mr. Cowherd to manufacture in Canada, Mr. Cowherd had a number of machines on hand (at the time of Cowherd's death), and Mr. Foster continued the manufacture, and my impression is that he continued to contract with Mr. Foster until we got our shop in such shape that we could make ourselves....There was no time or period when we were not supplied with telephones for the public, either from Cowherd, Mr. Foster or our own manufacture. They were continuously manufactured, inasmuch as they were ready for the public always when they came for them." So far as the law requires a prompt introduction in Canada of a patentee's invention, the patentees have observed the law, as Mr. Sise remarks; but the protective policy of the Patent Act, they have, in intention and effect disregarded and defeated to a very large amount the industrial manufacturing value of the patented article. In support of the pleading that the importation of an instrument in parts is no importation, Mr. Wood, on behalf of the respondents, quoted a recent ruling of the English courts (*Townsend* vs. *Hawthorne*), in which case it was decided that the importation of the materials of a composition of matter was no infringement of the patent; "and," says the learned counsel with reason so far, "what is no matter of infringement cannot be a matter for illegal importation." So far so good; but the conclusion, which is correct in the abstract fails in the concrete, as applied to the present case. The materials of the composition are raw materials unworked, such as would be, in the present case, steel in bars, iron as a commercial article of trade, rubber, and even silk-covered wires; but the moment these are worked into shape and form, to constitute a Bell telephone, they cease to be raw materials and become a manufactured article. Mr. Tache, in his judgment, has anticipated the ruling of the English courts, in the very species of case cited by Mr. Wood. "It is not difficult, says Mr. Tache, to imagine a case in which the importation of all and every one of the component parts of an invention, to be simply put together in Canada, would not be an importation in the meaning of section 28 of the Patent Act ....for example, the case of a patent granted for a composition of matter." It is immediately after this that Mr. Tache adds, referring to such cases: "every one of which must stand on its own merits." The other and last allegation of the disputants is that the patentees have refused to sell their invention after two years of the existence of their patent, namely, to the inhabitants of Port Perry in 1882, to Messrs Lohnes & McKenzie in 1884, to others, and generally refused to sell in order to monopolize the control of the telephonic operations throughout Canada, and derive from their invention more than they were entitled to for the use thereof. A question has been raised on the meaning of the words sale and license as applied to patents. One of the learned counsel was under a misapprehension about the signification of the words used by Mr. Tache in his decision :—"license the right of using on reasonable terms." In this sentence the

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word license is used in its broad technical sense in patent science; it does not mean a lease upon payment of a rental, but the absolute transfer of a property, which becomes vested in the licensee or purchaser *quoad* the result suggested by the nature of the invention and the extent of the purchase in point of number. Of course, if one or many of the public prefer to lease and agree to do so, there is no disability created by the law to prevent them from entering into such a contract. There are, in the nature of things, three sorts of contracts in relation to patents:—1st. The license to use, or by the purchaser furnishing himself with the means to use. 2d. The sale of the means to use the invention. 3d. The assignment of the whole or portion of the patentee's privileges. As tersely expressed by Judge Hall, in *Pitts* vs. *Hall* (2 Blatchford, 229): "a license, or assignment, or sale of a machine is a transfer *pro tanto*, of the property secured by the patent." In all these cases, however, it must be borne in mind that our Patent Act differs essentially from the English and the present American laws. Our patentees are bound to license, that is, to sell the use of their invention, and bound to see that their invention is not imported after twelve months, and that it be manufactured in Canada after two years, because connivance in an importation is equal to importing or causing to be imported. On the contrary, the English and American patentees are at liberty to import and at liberty to entirely withhold from the public use their inventions if they choose so to do; therefore, they can select their own conditions in a contract, in the nature of which they are bound, of course, when entered upon, but into which they are not forced by law. The instances of refusal to sell, which were the subject of evidence in this case, are several, but, with the exception of three, they are mixed or seem to be mixed with demands to use poles, wires, communication with lines and exchanges, which, naturally, the patentees are not bound to furnish. The three clear instances of refusal are: 1st, the case of Mr. Bate, of Ottawa, commenced in April, 1883; 2d, the case of Mr. Dickson, of Montreal, commenced in November, 1883; 3d, the case of Mr. Richard Dinnis, of Toronto, commenced in March, 1884. The correspondence is completed and certified by statutory declarations. In the case of Mr. Bate, he wrote on the 14th April, 1883, to the Bell Telephone Company of Canada asking them to give him their lowest price for three telephones, including transmitters, for a private line. He was answered by Mr. McFarlane that their agent at Ottawa was directed to call on Mr. Bate. Mr. Bate wrote a second letter to the company to explain that he wanted to purchase and not to rent the instruments. Mr. Sise, in answering this second letter, intimated to Mr. Bate the following: "We do not sell telephones, but we rent them." In the case of Mr. Dickson, a protracted correspondence took place, first opened with Mr. Scott, agent of the company, to be continued with Mr. Sise, in which Mr. Dickson insisted on his right to get the instruments as his property, according to law, and Mr. Scott and Mr. Sise declined to sell, but offered to lease or rent. To close the correspondence Mr. Dickson informed the company that being thus denied the purchase of the instruments, he had decided to have them constructed himself for his own use; to which threat Mr. Sise answered that they could not consent to an unconditional transfer, but would sell a Bell Telephone for thirty dollars, subject to the stipulation "that it is to be used only between certain specified points." In the case of Mr. Richard Dinnis, he wanted to purchase three sets of telephones to connect his office, his residence and his factory, and asked to be informed of the cost. Mr. Sise answered him that they had never sold these instruments, but that he (Mr. Dinnis) could have three sets rented at the rate of $20 per annum, he (Mr. Dinnis) building his own line; but that he would sell the instruments to him for $100 per set to be used only for the purpose stated by Mr. Dinnis. Mr. Sise refers Mr. Dinnis to Mr. Neilson, agent of the company at Toronto, for further information. Mr. R. Dinnis, in an interview with Mr. Neilson accompanied by Mr. Arthur Dinnis, both of whom render an account of the interview by statutory declarations, tried to get information from Mr. Neilson about prices, and asked if he could get the instruments at a more reasonable price and unconditionally, but was answered by Mr. Neilson that he could not give any other answer than the one contained in the letter of Mr. Sise.

The price was unreasonable and with a limitation of use. The case of Mr Bate was one of flat refusal. The two other cases were instances of protracted resistance, ended by offers to sell under restrictions, some of which were beyond the privileges of a patentee. The limitation as to where to use the invention, after purchase, is similar to a sale of a patented sewing machine to be used only in a particular house, or the sale of a patented plough to work only a given plot of land. The patent license in Canada accompanies the purchaser wherever he chooses to move on the wide territory of the Confederation, provided he does not use more than the number of articles purchased. The policy of refusal to license or sell, for the purpose of leasing at a rental, is made plain again by the answers, although very reticent, of the manager of the company to the interrogatories of counsel. A few quotations of his evidence will suffice:—"I do not think," says Mr. Sise, "there has ever been a set sold by us." "I would not swear that we have not refused to sell private telephones. I would not say we did." "I should not be able to say whether we had absolutely refused to sell unconditionally one or two or more instruments, nor would I say that we had not." "I do not think we ever sold an instrument unconditionally." The whole case is plain on the face of it; and it is also plain that the patentees or their representatives had in view to build up a commercial enterprise (for the benefit of the public as they contend), rather than to content themselves with getting their mere royalty on licenses or sales as patentees. With such intention, simply, there is nothing to find fault, so far as this tribunal is concerned, if the steps necessary to carry it out had not led them beyond the provisions of the Patent Act.

The conclusion is that the patentees, the respondents in this case, or their representatives, having extensively imported the patented articles, after the expiration of twelve months from the date of their patent; having not manufactured in Canada the said articles to the extent they were bound to do, after two years of the existence of their privilege; having resisted and refused to sell or deliver licenses as required by the statute, to persons willing to pay a reasonable price, for the private and free use of the patented invention, they have forfeited their patent.

Therefore, I decide that Alexander Graham Bell's Patent (No. 7,789) for "Bell's System of Telephony" has become null and void, under the provisions of section 28 of "The Patent Act of 1872."

J. H. POPE,
Minister of Agriculture.

Department of Agriculture,
Patent office, Ottawa, 24th January, 1885.

ANNUAL REPORT OF THE EDISON COMPANY FOR ISOLATED LIGHTING.

To the Stockholders of The Edison Co. for Isolated Lighting:

During the year ending November 1st, 1884, 143 isolated plants, aggregating 19,390 lights, have been installed, making a total, since the formation of your company, of 417 plants for 75,145 lights. These installations have been of almost every kind, as was explained in the last annual report, but during the present year the general depression of all manufacturing interests has seriously interfered with sales to factories, heretofore an important feature in your business.

In addition to permanent installations a profitable business has been done during the past year in renting plants to theatres, exhibitions, halls, &c.

The profits from lamp renewals have also been large, and they promise to increase from year to year.

Over two years ago a separate department was formed for conducting your business in New England. This department proved a source of heavy expense, exceeding $18,000 in a year and one quarter, without producing adequate returns, but subjecting your company to very serious losses from bad debts and other causes. As your Board could not see any reason whatever for its continuance, it was formally disbanded on July 1st, 1884, and the New England business is now conducted with profit through your New York office.

During the present year your company has been put to heavy expense for the purpose of taking part in several large electrical exhibitions, especially in one recently held at Philadelphia. Your directors felt bound to see that the Edison light was properly represented, but they now believe that the system is so well known, and its merits so generally recognized, that you can afford to hold aloof from many of these exhibitions, which, in themselves, do not produce any corresponding benefit. You can refer to the Edison light, whether isolated, underground, station or village plant, in actual operation, and your absence from these expensive exhibitions cannot any longer be misunderstood.

A source of constant trouble in the financial management of your company during the past year has been the heavy cash outlay incurred while each installation is in progress, and even after its completion, as payment is not made therefor until some time afterwards. The length of time which thus elapses is far greater than the credit which your company is allowed by the manufacturers of the machinery, &c., and for the *labor* of installing (a heavy item), cash must, of course, be paid. Furthermore, your company is obliged to carry a large stock of unemployed goods, to have them on hand for installations as required. Consequently, it may be said that the larger the business done by your company, the more difficult it becomes to make receipts take care of payments. Steps are in progress which, if successful, will correct this in part, but it is clear that your present paid-in capital is too small for your business, and it will be for your next Board to decide whether it may not be wiser to put the company in easier circumstances by making a further call for some part of your unpaid stock.

In the spring of 1884 negotiations were commenced between your Board and that of the Edison Electric Light Co., looking to the transfer to you of the business of exploiting and installing central station and village plants *within* the limits of gas territory. Such business *outside* of those limits already belonged to you un-

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der your original contract with the parent company. On the first day of September last, a contract was executed between the two companies (after ratification by their respective shareholders), by which you undertook such exploiting and installing within gas limits, on a basis of an equitable division of profits; but as it was recognized that this new business would subject you to additional expense and *might*, possibly, not produce any adequate returns, the Light company agreed to make the dividends on the stock of your company held by it, secondary to the payment of dividends on your remaining stock, as is best explained by the following extract from the contract, as executed:

ELEVENTH. Whereas the Light company now owns fifty-one one-hundreths of the capital stock of the Isolated company, and, under its said contract with the Isolated company, dated April 26th, 1882, is entitled to receive, without additional compensation, a like proportion of all future increases of said capital, which provision of the said agreement, it is agreed, this contract does not in any way alter or disturb; and, whereas, the Light company consents, during the continuance of this agreement, and as further and special compensation to the Isolated company, to make certain concessions touching dividends on its said stock, in favor of the other stockholders, to wit, the holders of the remaining forty-nine one-hundreths (which stock, for convenience of designation, is herein called *cash stock*, as distinguished from the Light company's holdings, herein called *Light company stock*): it is agreed as follows, that is to say:

1. All net earnings of the Isolated company, applicable to dividends, shall, during the continuance of this agreement, be applied, first, to paying a dividend of, or dividends aggregating not more than, eight per centum per annum on the said cash stock; second, to paying a like dividend, or like dividends, on the Light company's stock, aggregating not more than eight per centum per annum; and, third, after the said dividends aggregating eight per centum per annum on both classes of stock shall have been paid, any surplus shall be distributed among all the stockholders according to holdings, including both the cash stock and the Light company's stock.

2. As to the said dividends, each year shall stand by itself, and no deficiency in any one year, whether as to dividends on the cash stock or on the Light company's stock shall be carried over to another year.

During the past year your company has met with active competition from numerous infringers on the Edison patents, who, encouraged by the inaction of the Light company, have become more and more emboldened, until many of them now exist as organized companies, working in opposition to your own. Your Board is happy to say that the Light company is now taking active steps to protect its patents in the courts, and there seems to be every reason to hope that speedy and favorable decisions will be secured, thus justifying your claim to the possession of the only practical system of incandescent lighting.

Your attention is invited to the balance sheet herewith, from which it will be seen that the net profits on business completed during the ten months ending November 1st, 1884, have been $60,-248.62.

The great depression in business throughout the country has, however, affected some customers whose accounts were taken over from last year as good. As your Board has not thought it expedient to carry forward any assets of doubtful value, all these accounts have been written off to profit and loss, although some considerable portion of them will, in all probability, be eventually collected. In the same way losses, which were not anticipated on the 31st December last, have since been ascertained on certain experimental installations of the previous year, and these have also been charged off. The operations in 1884 have been sufficiently profitable to admit of all this, and still leave a small balance at the credit of profit and loss, and your capital is intact, with all depreciated or worthless assets written off. Consequently there appears no reason to doubt that, with the safer methods of business now followed, your company will be able in future to resume the payment of regular and satisfactory dividends.

The authorized capital stock of your company is the same as at the date of your last report, namely $1,000,000, made up as follows:

Issued to Light company for license		$382,500 00
Paid for in cash		361,938 66
		$744,438 66
Unpaid installments		8,176 34
		$752,615 00
Still to be issued to Light company for license		127,500 00
Stock not yet called, viz., 50% of $245,000	$122,500	
Less already paid in full	2,615	
		$119,885 00
Authorized capital		$1,000,000 00

By order of the Board of Trustees,

E. H. JOHNSON, *President*.

65 Fifth Avenue, New York, November 18th, 1884.

ANNUAL REPORT OF THE EDISON ELECTRIC ILLUMINATING CO.

To the Stockholders of the Edison Electric Illuminating Co. of New York City:

Your company has now completed the fourth year of its existence, and your board feel that the results achieved are a fair cause for congratulation as to the past and for encouragement as to the future.

Your enterprise was one of peculiar boldness. Starting almost from the moment that Mr. Edison had demonstrated the scientific success of his great invention, you undertook to apply practically, and to its fullest extent, a system which had scarcely been tried at all, except in the laboratory, and which, so far as underground and central station work was concerned, existed only theoretically. When the construction of the present central station was commenced there were in use perhaps a half-dozen small, imperfect, isolated plants; and with only these to guide you, you undertook and have carried to scientific and financial success the great problem of underground central station lighting by electricity in competition with gas.

At the date of the last annual report the First District had scarcely more than reached the point where its receipts were in excess of its expenses. During each and every month of the present year they have shown a handsome increase as compared with last year, and instead of a loss, as in 1883, the operations of 1884 will leave a surplus of fully 3½ per cent on the capital stock, after paying expenses of every kind.

The following table shows in detail the average number of customers and of lamps connected, the collections, operating and general expenses (including all repairs and renewals), taxes, etc., and the profit or loss for each quarter of the years 1883 and 1884. It will be remembered that prior to February 1st, 1883, the light was supplied, as an experiment, free of cost to consumers.

Month.	Average of customers connected.	Average of lamps connected.	Collections.	Operating and general expenses.	Loss.	Profit.
1883.						
Feb. March...	330	4,374	$3,788 64	$9,904 48	$6,115 84	....
Ap. My. June.	398	5,931	8,711 89	14,752 28	6,040 39	....
Jly. Aug. Sep.	439	8,685	15,689 01	15,197 31	....	$491 70
Oct. Nov. Dec.	483	10,172	24,900 11	17,693 08	....	7,207 08
1884.						
Jan. Feb. Mar	498	10,685	28,659 34	18,229 88	....	10,429 46
Ap. My. June.	541	11,594	25,400 54	18,148 97	....	7,251 57
Jly. Aug. Sep.	582	12,503	23,849 34	19,975 88	....	3,873 46

The financial results of the foregoing table are summarized in the following:

	1883.	1884.
February and March	$6.115 84 loss*	$10,429 46 profit
April, May and June	6,040 39 loss	7,251 57 profit
July, August and September	491 70 profit	3,873 46 profit
October, November and December.	7,207 08 profit	14,000 00 profit†
Net loss, 1883	$4,457 50	
Net profit, 1884	....	$35,554 49

* For two months only. The loss for three months would be even larger.

† The profits for December are estimated at	$5,500 00
The actual profits for October and November were	8,500 00
Making the estimated total for the quarter, as above	$14,000 00

As a matter of course, the profits of the station fall off considerably in the summer months, as will be seen from an examination of the foregoing tables. To neutralize this falling off in part, your company has undertaken to furnish electric motor fans to be run by current from the central station; and while their introduction last summer was not possible until too late to secure any considerable results, the fans met with such favor as to warrant the belief that next summer they can be developed into an appreciable and permanent source of revenue.

A heavy item in the operating expenses of the First District has heretofore been that of lamp renewals. Owing to imperfect electrical determinations in the construction of the district, and the consequent inequality of electrical pressure, the lamp breakage was unduly heavy. It is very gratifying to state that during the past summer these defects of construction have been mostly corrected, and improvements have also been made in the lamps themselves, with the result of raising the life of lamps from 400 hours of use in January to 914 hours in November, which is equal to a monthly saving of about $400 in operating expenses on the number of lamps in use at the present time.

The average monthly life of lamps during the past year, as

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reported by the superintendent of the station, has been as follows:

January	400 hours of use
February	523 " "
March	349 " "
April	448 " "
May	400 " "
June	389 " "
July	502 " "
August	558 " "
September	727 " "
October	730 " "
November	914 " "

The following additions have been made to construction account of the First District since January 1st, 1884:

New plant, including 2 engines, 150 h. p. each; 2 dynamos, 1,200 lights each; 2 regulators, and expenses of installing same	$34,125 08
Station apparatus	1,123 01
Street conductors, viz., 3,849¼ feet	17,140 39
House connections and original lamps	2,958 41
Meters	133 31
Tools and implements	22 68
Motors	2,439 00
Office fixtures	59 38
Total	$58,001 16

The expediency of these expenditures, which have only been made after careful deliberation, is best shown in the financial results achieved, which are due in a considerable degree to the fact that the increased expense of running the station as enlarged, bears but a small proportion to the increase of receipts secured by the enlargement. The station is even now taxed to its utmost capacity, and it is evident that further additions to the existing plant could be made with substantial advantage to the company. In fact, the superintendent of the station reports that there are now on file over 100 applications for the light, of which at least 50, requiring about 750 lamps, would furnish very desirable customers.

Notwithstanding the recent reduction of the price of gas from $2.25 to $1.75 per 1,000 cubic feet, our First District station has not yet lost a single customer, which is the best possible proof that our light, at its present cost (1¼ cents per hour of use for lamps of 16-candle power), is found more desirable and satisfactory than gas even at the reduced price.

Of even greater importance, however, than the enlargement of the First District is the question of starting a district up-town. When your company was organized it was believed that its authorized capital would be sufficient to install both an up-town and a down-town district, but the delays and difficulties encountered with the down-town district were so great that the capital proved insufficient to install it alone, and even now your company finds itself in debt to the Light company for more than $70,000 for money advanced and balance of license, though against this your company claims certain offsets arising from the increased cost of the First District. In fact, the down-town district has been operated in the face of every possible disadvantage; but your board has believed that it was pursuing the right policy in showing what could be done under all these unfavorable circumstances, hoping thereby to shorten the time when it could enlist the necessary capital for work up-town.

The present district, which is bounded by Wall street, Broad street, Exchange place, Broadway, Spruce street, and the East River, is perhaps the least remunerative in the city, being occupied mainly by banking and other offices, which are closed on an average earlier than 6 o'clock, so that the hours of light consumption are very short.

A far richer field for your enterprise would be an up-town district, extending perhaps from 23d street to the Central Park, and from the 8th to Madison avenues. Not only would the hours of light consumption be much longer, but, owing to the great cheapening now made in the cost of everything connected with the Edison system, the cash capital required entirely to install and equip a station of light-giving capacity equal to the present one (and situated somewhere within the limits indicated) would be, as appears from preliminary estimates already made, not over one-half the amount spent for the down-town station. It is estimated that during the coming year this latter will earn fully 5 per cent on its stock, or equal, in other words, to 10 per cent on the cost at which it could now be duplicated. In an up-town station, where there would be longer hours of light consumption, it seems very reasonable to assume that half again as much profit, or at least 15 per cent net per annum at the start, could be earned; and were it not for the general depression at present affecting all electric light investments, embracing both the good and the bad, your trustees would not hesitate to come before you at once with some scheme to raise the capital for a large up-town installation. In all probability considerably more than 15 per cent. could be earned in an up-town district, but even on this basis it is felt that with the results already achieved in the First District, the time is near when a successful plan can be formulated for an up-town station, and as soon as one large station is started up-town there can be no doubt that the extension of the system throughout the entire city of New York will follow.

Your present capital stock is the same as at the date of the last report, viz., $1,000,000, made up as follows:

Paid in	$987,010
Unpaid subscriptions	11,490
Stock in treasury	1,500
	$1,000,000

As the fiscal year of the company ends on the 31st of December, it is recommended that the time for the annual meetings in future be changed to the third Tuesday in January, when the actual results of each previous twelve months can be presented in their entirety, without the necessity for partial estimates which at present exists.

By order of the Board of Trustees.

S. B. Eaton, Vice-President.

OPINION OF JUDGE SHIPMAN IN THE PRINTING TELEGRAPH CASE.

This is a motion for a preliminary injunction against the alleged infringement of reissued Letters Patent, No. 3,810, dated January 25th, 1870, granted to the Gold & Stock Telegraph Co., as assignees of Edward A. Calahan, for an improvement in telegraphic printing instruments for registering gold, stocks, &c.

The original patent was granted April 21st, 1868. The reissued patent contains five claims, the second of which is said to be infringed by the defendants by the use of a patented machine invented by Stephen D. Field.

No adjudication has been had upon the Calahan patent, except the case, in this court, of the present plaintiff against Charles J. Wiley, wherein the validity of the 3rd claim only was involved. The principal question in this case, viz.: as to the construction of the words "jointly or separately" in the second claim, did not arise in the Wiley case.

The present bill was filed on May 29th, 1883, at which time the defendant, had 20 Field printing instruments in process of construction. Before that time they had used the instrument for the purpose of experiment. The plaintiff's *prima facie* case was closed on July 23rd, 1884. The difficulty of ascertaining and proving the construction of the Field machine was a cause of delay.

Therefore, no testimony has been taken by the defendants, although the time designated by the court in which to take and close their proofs has expired. They have presented before me divers affidavits in which their defense is set forth.

The principal question in the case is the construction of the word "jointly" in the second claim, and when I add that it is substantially agreed that the state of the art in 2-wheel printing, at the date of the original Calahan patent, is represented in the Johnson or Theiler mechanism, the question may seem to be a very simple one, but the plaintiff's proofs and the defendants' affidavits show that it is really one upon which much learning, skill and time may be profitably employed, and which is not of ready solution.

The reason why the motion is pressed, under this state of facts, is obvious and is not concealed. The Calahan patent will certainly expire on April 21st, 1885. It is said by the defendants that it will expire on March 16th, 1885, by reason of the expiration at that date of the English patent for the invention. Necessary delays have occurred in the taking of the plaintiff's *prima facie* proofs. The defendants have not been in haste in taking their testimony and the life of the patent is rapidly approaching its close. There is a strong and very urgent motive to have a decision upon the question in the case before the invention is open to the public.

Assuming that the whole testimony is before the court, and that it has been completely presented and can be thoroughly studied on this motion, the fact still remains that a temporary injunction is being sought upon a question which now arises for the first time and which must be examined with the care and patience necessarily incident to a case wherein men's minds must differ. In other words the attempt is made to make a motion for a temporary injunction applicable to a state of facts to which such a motion is not adapted.

It is no answer to the argument that upon a motion for an injunction, *pendente lite*, the question must be susceptible of ready answer and the case must be free from reasonable doubt, to say that this whole case is now before the Court, and that the questions, after the state of the art is ascertained, are those of law which can be settled as well now as at final hearing, because a motion for a temporary injunction is not designed for the adjudication of doubtful questions which have not previously been discussed. While I understand the pecuniary damage to the plaintiff arising from delay, if its rights are being infringed, the history of the case shown and my examination of it satisfies me that the question is one which is open and which needs the attention usually to be given to cases upon final hearing.

The motion is denied.

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THE TELEPHONE INTERFERENCE CASES.

The proceedings in interference involving the question of priority of invention of the speaking telephone, which have been pending in the Patent Office since March, 1878, were decided by the Examiner of Interferences in the first instance on most of the issues involved in favor of A. G. Bell; but J. W. McDonough was awarded priority on one important point, which substantially covered the magneto-receiver. The claim in dispute is as follows: "A telephonic receiver consisting of the combination in an electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality."

Upon appeal to the Board of Examiners-in-Chief, this decision was reversed and priority awarded to Bell. McDonough then appealed from the decision of the Board, and a hearing has been had before the Commissioner of Patents on the appeal. McDonough's counsel moved to reopen the case and remand it to the primary examiner, on the ground that new evidence had been discovered to the effect that the telephone could transmit articulate speech by means of an interrupted current. It was also contended that the Board had decided against McDonough on the ground that his instrument was not operative, whereas the question of the operativeness of the instruments was not within their province to determine, and that therefore the decision of the Board was invalid. The motion was overruled by the Commissioner, who held that it was competent for the Commissioner on appeal to remedy any invalidity of the decision of the Board, and also for the reason that the motion had been filed without due notice to opposing counsel. William L. Voelker also appealed from the decision of the Board awarding priority to Bell in interferences A and B, and against Edison in interference No. 1. Elisha Gray also appealed from the decision in favor of Bell in case G. Several eminent counsel appeared in behalf of the contestants,—Chauncey Smith and J. J. Storrow for Bell, Colonel Dyer for Voelker, W. D. Baldwin for Gray, Roscoe Conkling for Edison, and General S. A. Duncan for McDonough. The decision of the Commissioner had not been announced up to the time of going to press.

STATE TAXATION OF TELEGRAPH COMPANIES.

On January 20th, the Court of Appeals of New York state rendered an important decision upon the question of the right to tax the entire capital stock of a telegraph company under the statute of 1881. The Western Union and Gold and Stock Telegraph companies have for 3 years resisted the payment of the whole tax levied on dividends declared. They maintained that a tax could not be collected on the dividends on the whole capital stock of the company, but only on the value of the property in the state. They paid the amount due on property situated in New York state, but have fought the payment on the whole capital through all the courts. They argued that the telegraph law of 1861, and not the corporation tax law of 1882, applied to them, while the State Comptroller and Attorney-General held that the tax must be raised on the entire dividend declared. In the Western Union suit Judge Samuel Hand, of Albany, who was referee, gave judgment for the state and sustained the doctrine that the whole capital stock could be taxed, as the law of 1861 was virtually repealed by that of 1882. Appeals were taken through Term, on this and the Gold and Stock Telegraph case to the Court of Appeals. The principal argument was made on the latter, as the Gold and Stock party thought their position was stronger than in the Western Union suit. The Court of Appeals decided in favor of the state. The judgment of the lower courts, so far as it allows interest, is modified, and as modified the judgment is affirmed. All the judges concur except Chief Judge Ruger, who was not sitting. The amount involved is, according to Attorney-General O'Brien nearly $1,000,000.

TEMPORARY STOPPAGE OF THE HELL GATE LIGHT.

The electric light at Hell Gate went out on Saturday morning, Jan. 3, at 4 o'clock, and the brilliant illumination was withheld until Tuesday evening. The stoppage of the electric light was caused by the fact that a part of the screws attaching the armature to the shaft gave signs of being loose. The attendant engineer, noting this, decided that it would be advisable to cut off the light. Owing to the circumstance that there was a lack of proper tools, such as those which are in use at the Cleveland factory, the repairs occupied the time from Saturday until Tuesday.

"Since the light was first placed at Hell Gate last November," said Mr. C. P. Whitney, Secretary of the Brush-Swan Electric Light Company, "there have been no mishaps worth calling by the name. Once a couple of globes were broken by a bird and the lights went out. Of course the weather has once or twice occasioned annoyance. One night the lights went out, owing to the presence of sleet on the elevator, which kept the attendant from going up. The government is perfectly satisfied with the apparatus and its workings, and the plant has been fully settled for."

Mr. Whitney stated that a duplicate apparatus had already been ordered, so that such a delay in electric lighting of Hell Gate could never occur again. "The original objection of the pilots," he said, "which was not very general, is, we are assured by the government officers, entirely removed. During the nights in which the lights were out, there were many complaints from parties using the water about Hell Gate. Great regrets were expressed at the absence of the lights. Some of the captains of the Sound boats, I have been told, have concluded that it was a very great advantage to have the Hell Gate electric illumination, and that it was materially useful in navigation. It certainly is," concluded Mr. Whitney, "a permanent institution, and is now generally understood to be such."

AFFAIRS OF THE BANKERS AND MERCHANTS' TELEGRAPH CO.

A Referee in the suit of Alexander H. De Haven, a stockholder, against the Bankers and Merchants' Telegraph Co. and its Receivers, who were appointed in the sequestration suit brought by Austin G. Day, a judgment creditor of the company, Thomas S. Moore reported last month that the Receivers should be allowed to issue $1,500,000 of certificates, which should be a first lien on the company's property, and the proceeds of which should be used in settling all claims against the company, excepting those of the holders of its mortgage bonds. In his report, Referee Moore stated that the Bankers and Merchants' company had in its treasury $99,000 of the bonds under the mortgage of $10,000,000 given by it to the Farmers' Loan and Trust Co.; $5,115,000 of them were in the hands of purchasers, and $4,786,000 of them were pledged as security for its notes representing $784,874.18. Besides the notes last mentioned, the company owed $372,209.37 to unsecured creditors for work and material, $145,000 on coupons of bonds of the Southern, and American Rapid Telegraph companies, both of which corporations it controls; $290,000 on bonds issued under a mortgage of the New York and Washington line, $8,700 as interest on those bonds, $4,800 for taxes, $130,000 on Receivers' certificates, issued to enable the Receivers to get possession of certain Western branch lines, and $97,000 borrowed money, for which the Receivers are yet to issue certificates. The $130,000 of certificates were made special liens on the property they were issued for.

Referee Moore also reported that if the gap between Hammondsport, Ill., and Chicago, and that between Meridian, Miss., and New Orleans, were closed, as they could be readily and cheaply, as the material for the connecting lines was on the ground, the business of the company would be greatly benefited. In Referee Moore's opinion, Receivers' certificates, if made a first lien on the property of the company, could be sold for par, or not less than 90, and that the proceeds of the sale of $1,500,000 could be made to redeem every liability of the company, excepting the bonds issued under the ten million dollar mortgage. Judge Donohue has made an interlocutory decree reappointing Messrs. Newcomb and Smith as Receivers of the company, and authorizing them to issue the certificates representing $1,500,000.

THE BELL TELEPHONE PATENT IN CANADA ADJUDGED VOID.

We mentioned in our December number that the Toronto Telephone Manufacturing Co. had commenced proceedings in the Patent Office of the Dominion of Canada, to set aside the patent of Alexander Graham Bell, of August 22, 1877 (No. 7,789), and declare it void under the provisions of section 28 of the Act of June 14th, 1872, respecting patents of invention. This section is as follows :—

> Every patent granted under this act shall be subject and expressed to be subject to the condition that such patent and all the rights and privileges thereby granted shall cease and determine, and the patent shall be null and void at the end of two years from the date thereof, unless the patentee, or his assignee or assignees, shall within that period have commenced, and shall, after such commencement, continuously carry on in Canada the construction or manufacture of the invention or discovery patented, in such manner that any person desiring to use it may obtain it, or cause it to be made for him at a reasonable price, at some manufactory or establishment for making or constructing it in Canada, and that such patent shall be void if, after the expiration of twelve months from the granting thereof, the patentee, or his assignee or assignees, for the whole or a part of his interest in the patent, imports, or causes to be imported, into Canada, the invention for which the patent is granted ; and provided, always, that in case disputes should arise as to whether a patent has or has not become null and void under the provisions of this section, such disputes shall be settled by the Minister of Agriculture or his deputy, whose decision shall be final.

The defendant, in the first instance, unsuccessfully endeavored to procure a writ preventing the Minister of Agriculture from hearing the case, on the grounds that it was *ultra vires* of the Dominion constitution. The case came up on November 24th, and the hearing was continued on December 2d, 1884. On January 25th, 1885, a decision was rendered by the Minister of Agri-

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culture, declaring the patent void. The full text of the decision is given elsewhere.

The evidence taken in the case is said to have filled 1,500 pages, all of which has been carefully gone over by Dr. J. C. Tache, the deputy of the Minister, who is an expert in patent law.

At the time of the decision an action for damages was pending against the Dominion Telephone Co., on the allegation of infringment of this patent, which had been brought by the Bell Telephone Co. of Canada.

A GAS COMPANY ADOPTS ELECTRIC STREET LIGHTING.

A company was formed in Lockport, N. Y., about two months ago to introduce electric lighting, and it obtained from the city government the right to erect poles and string wires in the streets. After this the gas company, a monopoly of long standing, bought a controlling interest in the electric company, and it was thought this would end the electric light business, but on Jan. 12 a new company appeared before the common council and obtained the privilege to light several streets by electricity in place of gas. On Jan. 16 in the midst of a driving snow-storm the gas company commenced with a large force of men to pull down their gas posts and put up electric poles in place of them in Main street, which right had already been given by the council to the new company. A war of words between officers of the two companies occurred, but work was continued without interruption. Trouble is expected in the future.

PROGRESS OF INCANDESCENT LIGHTING.

Since writing the editorial on "Isolated Electric Lighting Plants," which appears in this issue, we have obtained the following information showing that there already exists a very considerable demand for this very class of work.

In this city, the United States Illuminating Co. has erected a plant of 1,800 incandescent lamps for the "Chelsea" apartment house, 500 for the building on upper Broadway, occupied by Aitken, Son & Co., and A. A. Van Tine & Harris; also 120 for Oppermann's Brewery on 45th street.

Contracts have also been closed by the same company with the Union Ferry Co., for lighting 2 of its new boats on the Fulton line with 75 lamps each, Cyrus W. Field's new Washington building on lower Broadway with 900, and the new station of the Pennsylvania R. R. Co. at Jersey City with 600 lamps. It will be remembered that the former station was destroyed by a fire originating from a gas explosion, the loss being estimated at $500,000. Attention was directed to this in our September issue in an editorial on the "Comparative Safety of Electric Lighting."

If the large gas consumers would devote more attention to this subject, they would doubtless effect greater reforms in the gas service than by holding indignation meetings, as was done on the 27th of January, with the vain hope of securing relief through legislative measures.

LAKE SUPERIOR COPPER ORE MINES.

The output of copper ore from the mines of Lake Superior for the year 1884 was as follows: Calumet and Hecla, 24,997 tons, being an increase of 4,372 tons over 1883; Quincy, 3,447; Franklin, 2,302; Osceola. 2,508; Atlantic, 2,199; Allouez, 1,371; Huron, 1,192; Central, 1,031; Peninsula, 865; Conglomerate, 841; Copper Falls, 606; Hancock, 461; Phœnix, 482; Wolverine, 440; Grand Portage, for five months, 154; Pewabic, 141. Product of all the Ontonagon County mines is estimated at 500 tons. The total products foot up 43,537 tons, an increase over 1883 of 6,052 tons. This ore will yield from 78 to 80 per cent. of fine copper after smelting. The mines are generally in good condition, but the unprecedentedly low price of copper has a depressing influence on all mines. This has already led to the suspension of work by the Peninsula, formerly the Albany and Boston, mine. On the other hand, the Conglomerate has resumed work, to be continued until spring. The property of the Pewabic has been sold to satisfy an execution issued at the suit of James H. Seager, S. D. North, of the Quincy mine, being the purchaser. The dividends paid last year were as follows: Calumet and Hecla, $1,300,000, making a total of $25,650,000 since its organization. Quincy, $280,000; total, $3,867,000. Central, $40,000; total, $1,710,000. Osceola, $625,000; total, $972,500. Franklin, $80,000; total, $348,000. Atlantic, $40,000; total, $260,000.

ERROR OF A NEWS AGENCY.

Considerable excitement was created among the oil brokers on January 20th by the report sent over Kiernan's Financial News printers that "the McCalumet Oil Company, of Pittsburg, the second largest oil company in the United States, has just made an assignment." The McCalmont was the company generally understood to be referred to, the name "McCalumet" evidently being an error of the tape. The secretary and treasurer of the company promptly denied the truth of the report and stated that the concern was in good condition and had reduced its indebtedness over $500,000 in the last nine months. Later the same officer furnished this statement:

> The false rumor was circulated over the tickers this morning that the McCalmont Oil Company had failed. The company promptly denied the report, set to work to discover its authors, and instructed its attorney, John Brooks Leavitt, to institute a suit for libel against Kiernan & Co., the owner of the ticker, for publishing the report, and also a suit against Knoblauch & Co., and C. I. Hudson & Co. for conspiracy in spreading it.

TROUBLE AVERTED.

The receivers of the Bankers' and Merchants' Telegraph Co. were presented with the following memorial, January 16th:

> "The employees of this company earnestly protest against receiving our salaries on the instalment plan, which has been in vogue for some months past. Money is still due us for the month of December and January, and the majority of us have incurred debts for the necessaries of life which must be met at once. Recognizing the fact that the law gives remuneration for labor performed preference over all other debts, we insist that you devise means for settling with us in full up to Jan. 16, on Tuesday, Jan. 20."

Checks were prepared in accordance with this request for all arrearages up to January 1st, otherwise, as is generally understood there would have been a general withdrawal from the service.

PROGRESS OF THE TWENTY-FOUR-O'CLOCK MOVEMENT.

At the annual meeting of the American Society of Civil Engineers, the committee on standard time reported that it had communicated with a number of prominent men in all parts of the country, and that 92 per cent. were decidedly of the opinion that the hours should be counted in a continuous series up to 24. Out of 171 railroad officials 98 per cent. were in favor of the change. Telegraph interests were reported to be in full sympathy with the movement, President Green being given as authority for the statement that besides reducing the number of errors, the transmission of fully 150,000,000 letters would be annually saved.

ELECTRIC LIGHT AND POWER.

Domestic.

Quincy, Ill., and Trenton, N. J., are among the cities which now have their streets lighted by electricity.

The Newton (Iowa) Electric Light Co. has filed articles of incorporation with the Secretary of State. Capital stock, $25,000.

The works of the Crump Label Co., at Montclair, N. J., are now lighted by 300 Weston incandescent lamps, and the Favorite Mills at Jersey City by 250 of the same.

The Electric Light Co. of Dubuque, Ia., having discovered that it has been losing $1,000 per annum, resolved at a late meeting to discontinue its lights, and offer the plant for sale at half price.

Atchinson, Kansas, after ten days' experience with the electric light, developed such a demand for more of the same that the local company has arranged to double its capacity.

The works of the Gilbert Manufacturing Co. at Ware, Massachusetts, are now lighted by arc lamps, which are said to be preferred to the incandescent.

The H. C. Frick Coke Co., of Connellsville, Pa., has been making experiments on the incandescent electric lamp for use in the mines. The principal point to be determined is the cost of the light. The electric light is also being introduced in some of the Schuylkill county mines.

The following tariff decision is of interest to colleges: "Dynamo-electric machine, although adapted, as claimed, for use in a college to produce illumination for projection of pictures on a screen in illustration of subjects of instruction, is not dutiable as a philosophical instrument, but is subject to a duty of 40 per cent. ad valorem as a manufacture of metal." (Letter to the Collector of Customs at Boston.)

W. H. McGrath, superintendent of the Brush Electric Light Co. in New York city, says "We run from our two stations 1,300 arc lights, 344 for city lighting, the remainder for private use. To do this requires fifty dynamos, 1,400 h. p., and over 300 miles of wire. In our stations we never had an accident. On December 20, the New York company was five years old. Some of the machinery has been in almost continuous use since 1879, and without apparent depreciation. New York streets will soon all be lighted by electricity. No one corporation could afford to put its own wires underground. There is, however, little to hinder except the expense. Our business is a profitable and growing one. The chief advantage we have over gas plant in the manufacture of light is on the score of labor, coal and the matter of depreciation of which I spoke. We can get a h. p. by the consumption per hour of 2 3-10 pounds of, say, $3 coal."

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Foreign.

The *English Mechanic* doubts whether the elevated railways will be operated by electricity for some years to come.

The electric light, says the *Dyer*, is being introduced into many of the dyehouses of Bradford (England) with great success, and affords a cooler and purer air than gas. The arc light is found to be useful for matching shades, whilst the incandescent lamp is of use in grey rooms, cleaning rooms, &c., where benzine is employed, or in any place where there is danger of fire.

The Société Espagnole d'electricitie de Barcelone has now in operation in different cities and towns in Spain, 504 arc, and 924 incandescent lamps. Of these, 185 arc and 281 incandescent lamps are in the city of Barcelona.

Austria is going into electric railways on a liberal scale, an extensive system of communication being planned, at a cost of 7,000,000 florins. The house of Siemens & Halske, which has done so much for the devolopment of the industrial uses of electricity, is to construct the projected system.

ELECTIONS AND APPOINTMENTS.

The Standard Multiplex Telegraph Co. has elected as directors Clement A. Griscom, James D. Potts, Frank T. Frith, Franklin Jones, Wendell Goodwin, M. T. Pickering, P. H. Delany; President, Clement A. Griscom; Vice-President, Wendell Goodwin; Treasurer, W. H. Barnes; Secretary, E. A. Calahan.

The Commercial Telegram Co. has elected the following directors: J. H. Prall, Richard S. Newcombe, Geo. H. Pell, John B. Scott, A. H. DeHaven, Charles E. Quincey, Geo. Turnbull, J. V. Bonhier, Geo. L. Hutchings, James G. Smith, J. G. Case, G. S. Mott, S. D. Field, A. H. Baldwin and C. Mingesheimer.

MISCELLANEOUS.

At a recent meeting of the Franklin Institute, it was stated that the electric fire-damp indicator had been tried with signal success, in some West Virginia mines. This indicator is the invention of a Cincinnati mechanic.

MANUFACTURING AND TRADE NOTES.

The Western Electric Co. is making at the Chicago factory a multiple switch-board for Stockholm, Sweden; putting in a 50-light plant for the Western Indiana depot, Chicago; a 25-light plant for Commodore Davidson's new opera house and skating rink, St. Paul, Minn., and another 25-light plant for Rand, McNally & Co., Chicago. This company recently shipped a 12-light plant to Antwerp, Belgium, and a 12-light plant to South Melbourne, Australia. In the other branches of business it is fitting up the new Montezuma Hotel, at Las Vegas, New Mexico, the new Windsor Hotel, New Orleans, La., and Hotel Royale, at same city. The works are running full time.

PERSONAL MENTION.

Prof. T. C. Mendenhall has been appointed Chief Electrician of the U. S. Signal Bureau.

RAILWAY SERVICE.

A complete set of electric railway signals has been presented to the Massachusetts Institute of Technology by the Union Switch and Signal Co.

THE TELEGRAPH.

Domestic.

Wm. O. Ross, a stockholder of the Baltimore & Ohio R. R. Co., has brought suit against that corporation in the U. S. Circuit Court at Baltimore, to ascertain the amount of money advanced by it, and on what authority, for the purpose of constructing and operating its telegraph system. He believes $3,000,000 has already been expended.

Foreign.

The telegraph wires are carried through the Alberg tunnel by 4 cables containing in all 14 wires. They weigh 150,000 lbs. and cost nearly $40,000. Two are cased with iron, one with lead, and are placed in a carefully protected channel below the track level. The fourth, with but one wire for railroad signaling, is suspended above ground.

THE TELEPHONE.

Domestic.

The Magic Telephone Co. has been incorporated by Samuel E. Landis, Wilbur F. Hoffman, and Josiah Bryan. It is to have a capital of $500,000.

Judge Nixon, at Trenton, has issued a preliminary injunction restraining the New Jersey Overland Telegraph Co. from constructing, using or selling the patented improvement of the American Bell Telephone Co. till the further order of the court. It is said that the company has notified its subscribers that their service must be suspended.

The Globe Telephone Co. has filed articles of incorporation in the county clerk's office, Camden, N. J. The capital stock is $500,000, and the incorporators are James Work, Thomas E. James, Thomas H. Leigh, of Philadelphia, and W. W. Goodwin of Camden.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 59 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From December 23, 1884, to January 20, 1885 (inclusive).

Alarms and Signals:—*Circuit-closer for Alarms*, A. Lungen, 309,790, Dec. 23. *Fire Alarm Box*, W. C. Hess, 310,424, Jan. 26. *Burglar Alarm*, W. F. H. O'Keefe, 311,027, Jan. 20.

Clocks:—*Secondary*, G. and F. Trippen, Jr., 309,809, Dec. 23. *Time Indicating Apparatus*, J. C. Wilson, 310,106, Dec. 30. *Electro Pneumatic System*, C. A. Mayrhofer, 310,530, Jan. 6.

Conductors, Insulators, Supports and Systems:—*Joining Conduit Sections*, B. Williams, 309,907, Dec. 30. *Insulator*, H. L. James, 310,059. *Binder for Electrical Conductors*, J. Brady, 310,177, Jan. 6. *Manufacture of Conductors*, A. A. Cowles, 310,258. *Metallic Curbing for Containing Wires*, P. H. Griffin, 310,271. *Conductor*, H. C. Watt, 310,345. *Press for Manufacture of Insulators*, G. W. Weyman, 310,484. *System of Electric Lighting*, O. Gassett, 310,663, Jan. 13. *Apparatus for Distributing Electricity*, same, 310,664. 310,665. *Protector for Underground Pipes*, W. R. and J. M. Rowbottom, 310,727. *Underground Housing and Insulation for Conductors*, E. C. Townsend, 310,748. *System of Generating and Regulating Currents*, E. Weston, 310,763. *Conduit Pipe*, T. Bacmeister, 310,773. *Machine for Making Compound Wire*, J. W. Ells, 310,805. *Cable*, H. A. Clark, 310,879, Jan. 20. *Device for Securing Wires to Poles*, G. L. Broomhall, 310,931. *Suspension of Aerial Cables*, E. T. Gilliland, 310,938. *Art of Making Wire*, T. Midgley, 310,956. *Manufacture of Insulating Compound*, A. Muirhead, 310,957. *Apparatus for Manufacturing Compound Wire*, M. G. Farmer, 310,993. *For Coating Wire with Metal*, same, 310,994. *Process of Manufacturing Compound Wire*, same, 310,995. *Lightning Conductor*, J. R. Fricke, 311,115. *Connection for Conductors*, E. H. Johnson, 311,130.

Dynamo Machines and Motors:—*Motors*, W. H. Chapman, 309,522, Dec. 23; C. C. Peck and W. H. Chapman, 309,562. *Regulator for Generators and Motors*, W. K. Freeman, 309,536; B. F. Orton, 311,141, Jan. 20. *Armature for Dynamos*, B. F. Orton, 309,560, 309,735, Dec. 23; C. F. Brush, 310,876, Jan. 20. *Dynamos*, E. Weston, 310,762, Jan. 13; H. R. Boissier, 310,782. *Brush Holder for*, same, 310,780.

Galvanic Batteries:—E. Weston, 310,004, Dec. 30, W. K. Kidder, 310,831, Jan. 13. *Galvanic Polarization Battery*, C. A. Faure, 309,939, Dec. 30.

Ignition:—*Gas Lighter*, A. R. Molison, 309,971, Dec. 30; C. W. Weiss, 310,002.

Lamps and Appurtenances:—*Arc Lamps*, J. B. Allen, 309,816, Dec. 30; A. Davidoff, 310,124; L. G. Woolley, 310,630, Jan. 13; S. H. Short, 310,736; N. McCarty, 310,837; W. Hochhausen, 311,073, Jan. 20. *Focusing Arc Lamp*, W. Hochhausen, 311,074. *Voltaic Arc Lamp*, W. P. Patton, 311,142. *Regulator for Lamps*, C. L. Buckingham, 310,119, Dec. 30; H. P. Boissier, 310,781, Jan. 13. *Cut-out for Lamps*, same, 310,783; W. Hochhausen, 311,072, Jan. 20. *Incandescent Lamp*, O. A. Moses, 310,145, Dec. 30; C. A. Hussey, 310,516, Jan. 6. *Holder for*, T. W. Bryant, 310,373. *Socket for*, S. Bergmann, 311,100, Jan. 20. *Thermal Cut-out*, W. Stanley, Jr., 310,472, Jan. 6. *Manufacture of Incandescents*, E. Weston, 310,761. *Combined Gas and Electric Light Fixture*, P. H. Klein, 311,131, Jan. 20. *Illuminating Point for Electric Light*, C. F. Brush, 10,544 (re-issue), Dec. 23.

Measurement:—*Measuring Apparatus*, M. G. Farmer, 309,937, Dec. 30; J. Canderay, 310,252, Jan. 6.

Metallurgy:—*Process of Separation for Metals*, B. Moebius, 310,302, Jan. 6. *Apparatus for Separation and Deposit of Metals*, same, 310,533.

Miscellaneous:—*Apparatus for Operating Bolts*, W. Vogel, 309,585, Dec. 23. *Device for Applying Electricity to the Human Body*, 309,897, Dec. 20. *Dental Plugger*, J. H. Van Ness and M. A. Bland, 310,099. *Thermo electric Pad*, S. G. Kram, 310,140. *Plating Basket*, A. Murphy, 310,146. *Mariners' Compass*, J. Scotland and F. Cordon, 310,729, Jan. 13. *Dumb-bell*, J. H. Shaw, 310,733. *Electro-magnetic Clutch*, W. A. Rogers, 310,913, Jan. 20. *Shuttle Operating Mechanism*, E. S. Winchester, 310,970.

Railways and Appliances:—*Railway*, F. H. Dauchell, 309,606, Dec. 23. *Visual Signal*, F. M. Godfrey, 310,412, Jan. 6. *Signal*, C. R. Johnson, 310,519. *Railway System and Car*, M. H. Smith, 310,962, Jan. 20. *Railway Yoke*, C. Bullock, 310,558, Jan. 13. *Single Rail Circuit for Signals*, H. D. Winton, 311,050, Jan. 20.

Storage Batteries:—C. A. Faure, 309,838, Dec. 30; W. A. Shaw, 309,886; L. H. Rogers, 310,724, Jan. 13, S. Kalischer, 311,007, Jan. 20, 311,006.

Telephone Systems and Apparatus:—*Call-box*, E. Gray, 309,617, Dec. 23, *Microphone*, F. J. Semal, 309,742. *Switch*, J. D. Lyle, 309,791; F. W. Harrington, 310,890, Jan. 20. *Telephones*, 310,068, Dec. 30; H. E. Waite, 310,751. Jan. 13; H. P. Pratt, 310,961, Jan. 20. *Telephonic Apparatus*, T. F. Taylor, 310,094, Dec. 30. *Transmitter*, J. H. Rogers, 310,151. *Signaling Apparatus*, J. H. Cary, 310,379, Jan. 6. *Telephone System*, W. A. Jackson and W. R. Cole, 310,282. *Combined Spring-jack and Annunciator*, L. Townsend, and R. W. Moore, 310,749, Jan. 13; L. Townsend, 310,750.

Telegraphs:—*Means for Overcoming Static Disturbances*, C. Selden, 309,571, 309,572, Dec. 23; F. W. Jones, 310,684, Jan. 13. *Quadruplex*, C. Selden, 309,573, Dec. 23; F. W. Jones, 310,685, Jan. 13. *Autographic Reed Telegraph*, B. A. Brooks, 309,600. *Means for Preventing False Signals on Reversals in Quadruplex*, H. Van Hoevenbergh, 309,751. *Printing Telegraph*, G. M. Hathaway, 310,587, Jan. 13.

Expired Patents:—A list of the more important electrical patents which expire during the current month is subjoined:—E. S. Ritchie, *Holtz Electrical Machine*, 74,139 Feb. 4; D. Munson, *Lighting Rod*, 74,402, Feb. 11; W. N. McInnis, *Spring for Relay Magnets*, 74,925, Feb. 25.

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NEW YORK, MARCH, 1885.

DEFECTS IN LETTERS-PATENT.

THE result of the litigation between the Gold & Stock Telegraph Company and the Commercial Telegram Company which was decided in the United States Circuit Court a few weeks since, is not without important lessons to intending patentees and purchasers of patents for valuable inventions. The history of the case is briefly this :—In 1868, Edward A. Calahan was granted a patent for a printing telegraph instrument which has since become well-known as the "Calahan three-wire stock-printer." The invention was simple, in fact almost crude, in its conception. It contained two type-wheels rotating side by side in parallel planes, one of which was provided with type for printing the letters of the alphabet and the other for printing numerals and such fractional signs as were useful for the purpose for which the instrument was intended. Each of these type-wheels advanced independently by a step-by-step motion communicated by an electro-magnet, ratchet and pawl. A third electro-magnet effected the impression by forcing a strip of paper simultaneously against the peripheries of both type-wheels. It is obvious that under this arrangement the letters were printed in one line and the figures and fractions in another. A letter upon one wheel and a numeral upon the other could be simultaneously imprinted, or a character upon either wheel separately by presenting a blank space opposite to it upon the other wheel. In the use to which the machine was actually applied, that of printing stock quotations, the capacity to print jointly was useless, the only necessary mode of operation being to print the title of the stock in letters with one wheel and then to follow it with the price printed in numerals from the other wheel. It was also found in practice that this mode of printing the record in two lines was in itself advantageous, because it was more quickly and easily read.

The Gold & Stock Telegraph Company was organized in 1867 on the basis of this invention, and eventually became one of the most profitable telegraphic enterprises in the country. The Calahan patent has always been esteemed as one of its most valuable possessions. Two years ago a competing system was established by the Commercial Telegram Company, making use of an instrument which printed a record in two lines exactly resembling that of the Calahan instrument, and which, while it had the like capacity to print separately in either two lines, did not have the capacity to print simultaneously in both lines.

The Gold & Stock Telegraph Company thereupon applied for a preliminary injunction against the Commercial Company, alleging an infringement of one claim of the Calahan patent, viz.:—

> Two or more type-wheels moving independently and controlled by magnetism, and arranged so as to print jointly or separately upon one strip of paper in two or more lines, substantially as specified.

Upon the hearing, the learned counsel for the defendant contended that the meaning of this claim was doubtful and said in effect that no one could tell whether the patentee intended to embrace within his claim an apparatus of the described kind capable of either printing "jointly" or printing "separately" or whether he meant only to claim a machine capable of printing both jointly and separately. The machine of the patentee had the capacity to print both jointly and separately, while the defendant's machine could only print separately, hence under one construction of the claim the defendant's machine might infringe the patent, and under another construction it might not, and no one could tell from the face of the claim which was the right construction. The Court said, in effect, that the case turned on the proper construction of the word "jointly" and remarked that the defendant's affidavits showed that "it is really one upon which much learning, skill and time may be profitably employed and which is not of ready solution;" and therefore refused to grant the injunction. The only recourse now left to the complainants is a long and tedious litigation, by means of which, if successful, they may recover damages from the defendants, but cannot otherwise interfere with their operations.

If the solicitor who prepared the specification of Calahan's patent had worded the claim in such a manner as to be free from obscurity, and especially had he confined it to the novel and essential feature of the invention, the separate printing from independent type-wheels, it is probable that the Court would have felt no hesitation in granting an injunction.

It may be seen from this example how vast may be the interests depending upon a slight verbal ambiguity or an unskillful use of words in the claim of a patent. Few persons, other than lawyers and experts, have any conception how small a proportion of the whole number of patents in force are capable of affording adequate protection, in case of adverse litigation, to the inventions upon which they are based. But an insignificant fraction of the whole number of patents ever come before the courts for adjudication, yet a large proportion even of these prove to be defective in the essential point of protecting the real invention of the patentee. As a general rule it may be said if an invention is worth patenting at all, it is worth doing in the

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best possible manner. This is especially true in respect to electrical inventions, for the reason that these, if valuable, usually pass into the hands of large incorporated companies, and it is seldom now-a-days that these companies purchase a patent without first submitting it to a skilled expert for a carefully considered opinion of its validity and scope. The price paid is usually governed far more by the strength of the patent than even by the commercial value of the invention ; in fact the value of an invention may be trifling while strategic advantages arising from the ownership of the patent may be of enormous value. In the instance which we have mentioned, it is safe to say that a different wording of the disputed claim would have been worth some hundreds of thousands of dollars to the owners of the patent, if it could have been effected.

These considerations have now become more important than ever, in view of the position which has been taken by the Supreme Court in refusing to allow the enlargement of the claims of a patent by reissue. The defects in a patent are not usually discovered until an infringer appears, and it is seldom that this happens until it is too late to reform the original patent, so that the inventor often finds too late that the fortune which might have been his, has slipped from his grasp, owing to some trifling defect in the preparation of his patent papers.

ELECTRICAL RIGHTS OF WAY.

One of the most noticeable peculiarities of the telegraphic business is, that although it has been one of the most important and indispensable factors of civilization for over 40 years, its legal status in some respects has not yet, by any means, been positively defined. During this period not only has the original field of electric service been fully developed, but it has branched out in various directions, until at the present day the popular mind believes it, by reason of its wonderful adaptability as a servant of mankind, to be capable of fulfilling almost any desired mission. Yet, in spite of all its boasted progress, the telegraph system of to-day is to a great extent a sort of parasite, pursuing the business of conveying intelligence between different parts of the country by hanging on to the skirts of other organizations, without in itself being possessed of any actual right of way, except, as it were, by sufferance, over the innumerable routes which it covers. The authority of Congress in granting it the privilege of building along post-roads is disputed by states, municipalities and hamlets as an unconstitutional usurpation of power by the national government. The contracts by which the privilege of occupying railway lands has been permitted by their owners, have been attacked as being exclusive, and opposed to the public welfare. The advantages of railway routes for electric lines are now so generally recognized, that the difficulties in obtaining them have been among the many other obstacles to be met and overcome by the projectors of new companies. The avoidance of the multitudinous shade trees along the public highways, has rendered necessary the choice of three evils: a zig-zag line, the mutilation of branches, or the bodily removal of the trees. The occasional "trimming out" process which every turnpike line must occasionally undergo in order to keep the wires working at all, has without doubt been the primary cause of the opposition encountered in late years in securing street privileges in rural districts. Wherever telegraph wires may go, they are—and not without much reason—regarded as an unmitigated nuisance, excepting possibly in the wilds of Hungary, where it is asserted that they serve a useful purpose in protecting the inhabitants from the ravages of wolves, inasmuch as these animals are said to abstain from prowling in their vicinage.

The multiplicity of wires now in existence and their great prospective increase, has led us to the conviction that it will eventually become necessary for their owners to secure, under proper legislative authority, an exclusive right of way for telegraphic purposes by condemnation or purchase, the same as in the case of turnpikes, canals, railways and other public works. Upon land belonging in fee-simple to themselves, with no apprehension of being disturbed, a more substantial system of construction would be adopted, which would render communication absolutely certain at all times. This may be thought by some to be a Utopian view of telegraph construction as it should be, for the facts of telegraphic history have imbued us with the idea that its ways must of necessity be ways of short-sighted economy, and that its future must forever be hampered with questions of economy, competition, adverse legislation, bankruptcy and eventual government absorption.

The cost of a strip of land, say two rods wide, between New York and Boston for example, would not by any means be so great as to be prohibitory. The route might avoid the more thickly settled portions of the country, so that very little land of much value need be taken, while the entrance into cities and large towns could be effected by short sections of underground line or in any other convenient manner. A solid and substantial structure capable of sustaining many hundred wires might be placed upon such a right of way as this, where they would be free from the interference of trees and from the smoking of the insulators by railway engines. Under these conditions, we have no doubt that not only would the wires work far better than they do now, but that the cost of maintenance per mile of wire would be materially diminished. We should very much like to see some telegraph or telephone company whose managers had sufficient confidence in the permanency of the institution to undertake to do this. We have no doubt that it will be done by somebody, perhaps at no very distant day.

THE LIGHTING OF DEEP MINES.

There are perhaps no locations where artificial illumination is at once so important, and the problem of its satisfactory application so difficult of solution as in subterranean mining. In the case of coal mines, the ever present element of danger from explosions adds to the complexity of the conditions, and there has practically been no progress in the direction of the protection of life and property from these frightful accidents since the invention of the well-known safety-lamp by Sir Humphrey Davy seventy years ago. This device, although assuring the safety of the miner, when properly guarded, cannot be considered a satisfactory method of illumination. So defective has it proved in this respect in fact that miners frequently assume the risk of using a naked flame in order that a more powerful light may be obtained in particular cases. It appears that in practice the miner is beset with danger in either direction. A better light is required to enable him to examine the condition of the roof and its

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supports. Indeed, the danger from the fall of face coal or the walls is more imminent, and correspondingly more dreaded than the explosion of fire-damp, the presence of which may frequently be detected by the sense of smell. Although the liability of damage to property is great, the usual policy prevails among mine-owners of preferring to incur the risk of possible loss rather than submit to the certain although smaller expense of adopting preventive measures. While the use of electric lights has been suggested, much doubt has been expressed as to their perfect adaptability to the winding galleries and isolated chambers of our anthracite mines. Of course there is comparatively little difficulty in lighting an open mine, and an installation of this character has been in successful operation at the Mechernich mines in Rhenish Prussia for more than three years.

The satisfactory result in the open workings induced the company to introduce the system in the subterranean galleries. Here the danger which is always threatened by the falling of loosened pieces of rock demands thorough illumination of the interior. Pitch torches were formerly employed for examining the bore-holes and adjoining fissures after each explosion. The smoky atmosphere rendered the success of the arc lamp somewhat doubtful. In the first experiments lamps of 1,000 and 3,000 c. p. were used, with the positive carbon in the lower holder. While the effect was brilliant, yet the rays did not penetrate the white smoke cloud which collects immediately after the firing of a blast, but as the smoke settles in a few moments, it was thought advisable to suffer this slight interruption and use smaller lamps of 350 c. p., which proved efficient. Ten of these have since been in use, with about 10,000 feet of lead cable, which, by reason of its pliability, allows the positions of the lamps to be changed. The progress already made in this direction leads to the belief that the thorough illumination of mines may be accomplished through the agency of electricity, by the use of existing appliances already familiar to electrical engineers. It is by no means necessary that lights should be so numerous as to flood the galleries throughout their devious ramifications. Circuits could easily be so arranged that incandescent lamps might readily be attached or displaced as required. The use of the arc lamp would of course be inadmissible in mines subject to fire-damp. While admitting that there are various obstacles to be overcome in such installations, we are confident that there can be none which will not give way to the personal application of that ingenuity which has already won so many triumphs in more familiar fields. Not that it is necessary that our great inventors should devote their attention to this work, but that responsible companies should be induced to undertake such installations, and that practical men with varied experience be thus brought face to face with existing difficulties, and be allowed all requisite facilities for removing some of the most imminent dangers now attendant upon our mining industries.

DEATH OF LUTHER G. TILLOTSON.

Few names have been more closely identified with electrical interests in this country than that of Luther G. Tillotson, who died at his home in this city on January 31st. He was born at Ithaca, N. Y., March 1st, 1834, and after receiving a common school education began his business career in 1849, as an operator upon the line of the Erie and Lake Michigan Telegraph Co., of which his father, the late Daniel T. Tillotson, was then Secretary and Superintendent. His progress was rapid, and his ability was so well appreciated, that at the early age of 19 he was appointed superintendent of telegraph on the Erie railway, a position in which he subsequently won distinction as the pioneer of telegraphic train despatching as since developed into a distinct and important branch of railway organization and management. His advanced ideas on this subject were a characteristic manifestation of that foresight, decision and promptness of action which have distinguished his subsequent career. After nine years service with the Erie company, he became impressed with the idea that the future growth of the telegraph would create an important field for merchandising, and in order to avail himself of such a business opening, he resigned the superintendency of the Erie line, and established himself in New York city in 1862 as a dealer in telegraph and railroad supplies, occupying a small part of a Broadway store. His almost immediate success in this enterprise confirmed the correctness of his views, and on the 1st of November 1865 the firm was reorganized under its present title of L. G. Tillotson & Co., General E. S. Greeley and Mr. W. H. Holt being admitted as partners. Mr. Holt retired in 1866, since which time the membership has been limited to Messrs. Tillotson and Greeley.

The business policy of Mr. Tillotson, while eminently a progressive one, was nevertheless cautious. It was his aim not merely to keep thoroughly abreast of the march of improvement, but to establish the reputation of his house as a place where everything could be obtained which could possibly be required in the operation of a railroad or a telegraph in any part of the world from which orders might reach him. Men who were located outside the pale of civilization might order a suit of clothes as well as a cell of battery with entire confidence that the order would be faithfully executed, while upon at least one occasion a superintendent was called for. Such was the excellent judgment of Mr. Tillotson that his selection of a proper man for a position of that kind might well be implicitly relied upon.

Notwithstanding the fact that his guiding hand was felt to be ever at the helm, he did not by any means confine himself to the actual business treadmill. He traveled extensively in pursuit of rest and recreation, thus wisely compelling his associates and subordinates to become thoroughly familiar with every detail of his establishment, so that now, although he has gone out from among them forever, the house of L. G. Tillotson & Co. will long bear upon its character the lasting impression moulded by its lamented founder.

Personally, Mr. Tillotson was one of the most pleasant, genial and liberal of men, although his physiognomy indicated that firmness could, when occasion demanded it, develop into that resolute sternness, so essential to proper discipline in those executive positions which he had filled with such distinguished ability.

Although brought into association with the promoters of many important enterprises, he did not distract his energy by becoming actively identified with them, as he might easily have done. He was at one time a director in the American District Telegraph Co., but beyond this has not been prominently identified with any corporation.

In 1857 he married Miss Emma A. Glenn who survives him, but their only child died in infancy. He leaves an ample fortune, and by his request the firm name of L. G. Tillotson & Co. will be retained; a fitting memorial of the useful and busy life now ended.

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THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 45.)

THE clothes-pin attachment, like most great conceptions, is exposed to the fate of being anticipated. Hon. Amos Kendall, the early agent of Morse, was, before 1850, delivered of the following remarkable system of insulation which we give in his own words: "I think the following the cheapest mode of insulation yet devised, and as effectual as any: With a wide set saw, or otherwise, make a gap in the post downwards, at an angle of 45°, wide enough to receive the wire with its covering. Just cover the wire with the best india-rubber cloth, or a composition of which india-rubber is the chief ingredient, so far that the covering shall extend about 2 inches from the post on each side. Over that, wrap sheet-lead or tinfoil, not, however, extending more than an inch on each side of the post. Sink the wire so covered into the gap on the post, then pass large twine turned around the lead covering on each side of the post, and tie it tight round the side of the post opposite to the gap. It will have the double effect of confining the lead and turning off the water." Happily for the memory of Mr. Kendall he never tried this alleged insulator.

Another brilliant idea is embodied in the "pictur" below. It was first introduced into civilized society by an article in the New York *Electrical Review*, based upon a letter from Aguascalientes, Mexico, which states that the Zacatecas state telegraph lines use these apologies almost exclusively. The attachment itself, as clearly shown in the figure, is a piece of horn, with tip and butt sawn off, and a notch cut in the top. It is, of course, hollow, and surrounds the top of the bracket to which it is screwed. The line wire is passed through the notch and held there, by being fastened with a piece of No. 14 wire. The letter describing this remarkable appliance naïvely states that "these horn insulators, although poor insulators for telegraph, *are splendid anti-induction insulators for telephonic use.*" This statement lets the cat out of the bag. The horn insulators are poor for telegraphic purposes, because they are not insulators at all. Horn is not very much of an insulator at best, having about the same specific resistance as the hard skin of the hand of a laborer, and whatever insulation it possesses is lost by the method of fastening the wire. It is because of this non-insulating character that it will answer in a dry country for telephonic purposes, affording just sufficient leakage to keep the line clear of static induction. It is, however, probable that if the horn was dispensed with altogether, and the wire fastened directly to the bracket or pin, it would work just as well in dry weather. In wet weather, it is not likely that either wood or horn would prove eminently satisfactory, even for telephonic service.

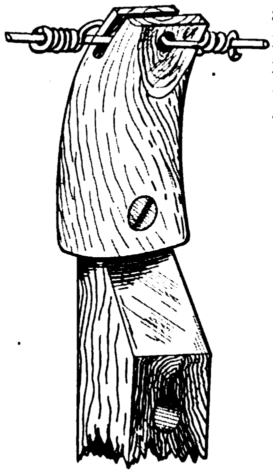

FIGURE 6.

It is a pleasure to look away from these oddities, to an invention in insulators which possesses real merit, and which, when better known, will be extensively employed. I refer to the form of insulator shown in figure 7.

A glance will show the nature of the improvement. In addition to the regular internal screw thread with which the insulator is as usual attached to the pin, there is an external screw on the apex of the insulator, but oppositely wound. That is, if the internal screw is right-handed, the external one is left-handed and *vice versa.*

The line-wire instead of being bound to the insulator with a tie-wire, is fastened with a special clip which is shown detached, in figure 8.

The object in providing the right and left-handed screws, is so that the wire can be fastened to the insulator, and the insulator screwed down on the pin by one and the same operation.

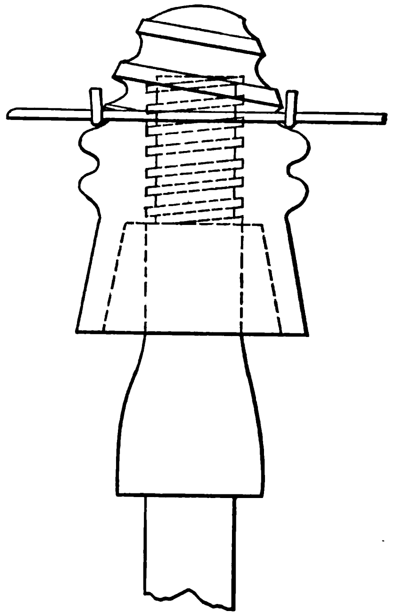

FIGURE 7.

In attaching the wire, the insulator is placed on the pin and given a couple of turns down. The clip is hooked on the line-wire with the ends of the hooks turned upwards. The loop thus formed is then slipped over the top of the insulator, and (care being taken to see that the clip goes down the thread of the screw first with the line-wire following) the insulator grasped by the hand, is screwed down on the pin as far as it will go, the outside screw at the same time insinuating itself into the loop of the line-wire and clip. These instructions for attachment, are by no means intended to serve as iron-clad rules to be observed, but an intelligent lineman observing the intention of the improvement, will readily adapt himself to it, and act according to the different conditions of each case. Even if insulators of this character are employed, circumstances may of course arise in which it will be found desirable to use the old mode of attachment. The insulator as now made, is provided with the ordinary circular groove, upon which the line-wire rests, for attachment with the old time tie-wire.

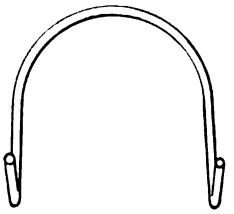

FIGURE 8.

It is, perhaps, unnecessary to recapitulate the advantages which are secured by the use of this form. It is well-known that a concomitant trouble of the old form of attachment was that scales of the zinc coating were sure to be rubbed off, thus leaving spots of unprotected iron wire at which oxidation would promptly commence. The leakage at each insulator may also be reasonably expected to suffer diminution, as the points of contact are lessened; while the line-wire suffers much less mechanical strain. It is also claimed that much time is saved in construction by its use, and it is evident that a single clip may be used many times, and that if it becomes necessary to detach the line-wire at any time, a few backward turns of the screw is the only operation necessary. Practical linemen whose opinion I have asked on this subject, concur in praising it highly and advocate its use, and it would therefore seem

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that one of the greatest obstructions which threaten innovations, *i. e.*, the opposition of workmen, will not retard the introduction of this insulator.

The application of the external or wire attaching screw, is the invention of an Englishman, J. Slater Lewis, and has been patented in the United States. The happy conception of forming the outside screw of opposite direction to the internal or pin screw, so as to provide for the simultaneous attachment of both line-wire and insulator is, however, to be credited to Frank L. Pope, and is fully described in a patent issued to that gentleman, December 25th, 1883. Both patents have, for the entire country, passed into the hands of the National Insulator Company, of which Messrs. Loren N. Downs and H. B. Lytle, of Boston, are respectively President and General Manager, and J. W. Duxbury, of Providence, R. I., Treasurer. These gentlemen recognizing the practical merit of the combination, and having, moreover, control of other improvements in insulators, have established themselves in the Equitable Building in Boston, and will doubtless take pleasure in furnishing any additional information that may be required upon the subject.

SUPPORTS FOR AERIAL LINES.

These are of twofold character—poles set in the ground, and house-top fixtures fastened upon the roofs and walls of buildings. The habitual haste and hurry of this nation is fully exemplified in the way telegraph poles are treated, from the moment they are cut until they are finally discarded. In the early days of the American telegraph, lines were hurriedly built for fierce competition—poles were set immediately after they were cut, often while the sap was still running, and sometimes without even being barked. The result was a short life and by no means a merry one. This reminiscence is forced upon my mind by the way in which the sad history is even now repeating itself. The lines for the telephone were built much more rapidly than those of the early telegraph; sometimes by men who had been to school in telegraphic construction; more frequently by men who had served no such apprenticeship, and who had, as it were, to learn a completely new business. How should they know that poles should be cut at least six months before they were to be used? And if they did know, had they time to wait? Nor is it an easy matter to persuade these gentlemen that it is wise to paint all poles, or to char the bottoms. The ten cents present is usually a more potent consideration than the dollar to be saved hereafter.

But two materials for poles need be discussed—iron and wood, and the latter is used almost universally in American construction.

The kinds of timber used for this purpose are principally the red and white cedar; chestnut, redwood, cypress and juniper. Spruce and pine are used to some extent, but they are not to be recommended. Where it can be readily procured at a reasonable cost, the red cedar is for all practical purposes to be preferred. It is not a handsome wood to look at, but is very durable, and lasts longer than any other which has come under my observation. Chestnut is also very good, being tough, elastic and tenacious of life. The white cedar also makes a fair pole, but is more brittle and addicted somewhat to snapping off short, when it receives an unusual strain. Cypress and juniper are much used in the south, but the latter seems to be preferable; inasmuch as cypress in a moist, warm climate is easily attacked by dry rot, which materially shortens its life. Juniper is a rather coarse grained wood, but is said to be very strong and durable.

All poles should be cut in late autumn or winter, when the sap ceases to rise. Careful estimates show that this precaution adds some years to the life of a pole.

A report furnished by the Western Union Telegraph Co. to the Superintendent of the United States census and published in 1882, show the average length of poles to be 27 feet, diameter across the top, 6 inches; average cost of each pole, not counting freight, $1.02; and the further statement was made, that the average life of a pole according to the wood used, and the location, was from 12 to 15 years, and in no case exceeded 25 years.

After cutting, they should be trimmed, stripped of their bark, shaved smooth, and then stacked for 5 or 6 months in such a way that the air may freely circulate between them, the lowest tier of the stack being raised a few inches from the ground.

POLE PRESERVING PROCESSES.

Wooden poles have been found to suffer severely from both dry and wet rot, but especially from the latter. They are particularly subject to decay at the ground line. To counteract these destructive agencies, the English constructors have from time to time adopted various preservative processes, applying them to poles before setting them up. These have been of two kinds:

First,—The impregnation of the poles with a strong solution of some metal salt, which salt combining chemically with the vegetable juices, produces compounds unfavorable to decay.

Second,—To impregnate the poles thoroughly with creosote.

It is not necessary to describe the former processes, since it is most unlikely that any of them will be adopted by American constructors.

Creosoting is accomplished by placing the poles in an iron receiver, exhausting the air from them and then forcing boiling creosote into them under pressure. This process has always given such eminent satisfaction that in the future when our timber is less plentiful than at present it will possibly be adopted. It has not, in the United States, as yet been thought desirable to employ any of these processes, as our supply of timber is yet large, and it is also thought that American timber is of a more durable character than that of Europe.

The statement is made that unprepared American timber will last as long as the prepared European poles; but an exception must be made in favor of those prepared with creosote. One protective process invariably used in England, we might, I think, profitably import, particularly as it is neither complicated nor expensive; that is the practice of roasting the butt end of poles in a slow fire until they are well blackened, for about 5 or 6 feet up, before setting them (care being taken not to burn them), and then tarring the blackened part and bottom with a mixture of coal and wood tar, and slacked lime. This compound operation prevents moisture from entering the buried part of the pole.

(*To be continued.*)

APPLICATION OF ELECTRICITY TO HOROLOGY.

BY CHARLES A. TERRY.

I.

One of the earliest and most obvious methods of determining the time of day, is that of noting the position of the sun by the length and position of the shadow cast by an opaque object, and probably the earliest artificial device constructed for the express purpose of measuring and indicating the passage of time was one depending solely upon this method, namely, the well-known sun-dial. The usefulness of this instrument depended, however, too much upon fair weather and a clear sky to render it of any great service, especially in such a climate as that of England. Graduated candles and sand-clocks or hour-glasses were accordingly resorted to for measuring time throughout the day and night, though these could hardly be relied upon as reasonably accurate time-keepers for any considerable periods. The first step toward the production of a mechanical time-piece, which would indicate the hour correctly from day to day, is found in the water-

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clocks used by the Greeks and Romans, but even these were very far from being reliable and regular in their operation.

The appearance then of the mechanical clocks "impelled by weights and wheels, so that they pointed out the hour, day and night with certainty" was an event of an import which all men must have appreciated. It is probable that such clocks were made during the latter part of the eleventh or early in the twelfth century. For nearly eight hundred years the human mind has been constantly at work developing, improving and perfecting the mechanical time-piece. At first thought it would seem that nearly everything that could be desired must be performed by the ingeniously constructed clocks of the present day, and yet as a matter of fact one is never surprised at finding a number of different clocks indicating as many different times. The ornamental clock upon the mantel usually varies from the tower-clock, and it is often the case that neither indicates the true time, while in any event it is necessary to correct them frequently to make them agree with some recognized standard chronometer or time-ball. Evidently, therefore, mechanical clocks have not in all these centuries been so far perfected that they can as a rule be depended upon to keep uniform time. Again, while it is true the advent of the mechanical clock removed the necessity of turning the hour-glass and filling the water-clock, yet it is no less true that even the labor of winding the spring or weight of the mechanical clock becomes irksome from constant repetition.

Two desirable results are therefore still to be attained in the construction of mechanical clocks, namely, accuracy and self-operativeness. It has been the especial aim of the inventors of electrical clocks to meet both these requirements, and it is proposed in this article to present a brief account of the first application of electricity to clock-movements and dials. In a consecutive article we will consider more in detail the subsequent improvements, the development of a complete electric-clock system, together with certain special forms of electric clocks of comparatively recent invention.

Soon after the first appearance of electric clocks, which was in 1840 or 1841, a considerable controversy arose as to whom belonged the honor of being the first inventor. The principal conflicting claimants were Alexander Bain and Professor Charles Wheatstone. Professors Daniell, Moseley and Willis, Dr. Arnot and W. Snow Harris publicly certified that, in their opinion, Mr. Wheatstone's claims were well founded. Mr. Bain and his friend Mr. Barwise maintained, on the other hand, that they were the exclusive proprietors of the disputed invention, both by right of conscience and also by royal license (they having obtained a patent), and that Professor Wheatstone had falsely and ungenerously sought to arrogate to himself discoveries and inventions of this character to which he had not the smallest rightful claim. It appears that the claim of Professor Wheatstone had for some two years, owing largely to his social position and the high standing of his professional and scientific friends, received general acceptance. In 1843, however, a new advocate of the claims of Mr. Bain appeared in the person of John Finlaison, the Actuary of the National Debt office. Mr. Finlaison published a pamphlet entitled "An Account of Some Remarkable Applications of the Electric Fluid to the Useful Arts by Alexander Bain, with a Vindication of His Claim to be the First Inventor of the Electro-Magnetic Printing Telegraph and also the Electro-Magnetic Clock." In commenting upon this pamphlet the editors of the *Mechanics Magazine*[1] writes as follows:

Mr. Finlaison is "a gentleman of great eminence in a most difficult branch of study, enjoying deservedly the confidence of Government and the public, and distinguished beyond most men for habits of patient enquiry and independent judgment. After a most acute and searching investigation of the several claims to the invention of the Electro-Magnetic Clock and Electro-Magnetic Printing Telegraph he determined the question in favor of Mr. Bain and his friends, Messrs. Barwise and Wright." The one great and important conclusion at which he arrives is "that Mr. Bain is the true man and Mr. Wheatstone (so far as regards the inventions in question) the pretender. For our own parts we adopt this conclusion of Mr. Finlaison's with great pain, holding in very high esteem Mr. Wheatstone's unquestioned and unquestionable merits in many other respects; but at the same time without hesitation; for it is a conclusion irresistably forced upon us, by an attentive, dispassionate and wholly unbiased consideration of the facts and arguments adduced by Mr. Finlaison in its support."

Mr. Bain originally came from Caithness in the north of Scotland, and at the time when he conceived the idea of employing electricity as a moving power for clocks and time-pieces, he was in the employ of John Barwise, an eminent London chronometer maker in St. Martin's Lane. In the pamphlet referred to, Mr. Finlaison says of him: Bain is a self-taught genius, kind-hearted, sober, temperate, candid, incapable of deceit, and utterly free of guile; but considering his years and opportunities well versed also in electrical science. Add to this that in practical mechanics he is not merely an artist of the very first order (an immense advantage this over the man of books, because his hand can execute whatever his mind conceives), but he is endowed moreover with inventive faculties of such fertility that no one can see the exercise of his ingenuity without wondering what new invention may next occur to his prolific imagination."[2]

As early as 1840, Mr. Bain proposed to operate a number of clocks simultaneously, to wind the going and the striking train, to correct the minute-hand from any slight deviation at predetermined intervals, and in fact, to perform nearly all the diverse operations which it has been the endeavor of subsequent electricians to perfect.

Early in 1841, a patent was granted in England to Barwise and Bain for improvements in the application of moving-power, to clocks and time-pieces. They proposed to construct a self-operating clock by securing to the pendulum of a mechanical clock an armature which was to be periodically acted upon by an electro-magnet, the electro-magnet being included in a circuit periodically closed by a sliding rod worked by the pendulum itself. The pendulum also carried a catch-spring which served to drive the clock-train. This device has been reinvented by innumerable later aspirants, but the successful and satisfactory operation of such a clock may well be doubted. A more important part of the invention is that relating to the operation of secondary clocks or dials. Two different plans for effecting this were proposed. The one consisted in completing an electric circuit successively through various conductors leading to as many secondary clocks. This was accomplished by causing a contact-spring, moving with the 'scape-wheel of an ordinary clock, to pass

1. Vol. 39, p. 64, July 22, 1843.

2. Alexander Bain was a native of Thurso, North Scotland, where he was born in 1811. He learned the clock and watchmaking trade and came to London in 1837 with the intention of following that business. While attending a lecture on electricity, soon after his arrival, his ingenious and fertile mind conceived the idea of applying electricity to clocks, which, in turn, led to the invention of a new form of electric telegraph. By the summer of 1840, he had completed models of both these inventions, which he showed to Mr. Baddeley of the *Mechanics Magazine*, who referred him to Professor Wheatstone. The latter interested himself in the invention, but the circumstance led to an unfortunate controversy, not altogether creditable to him. Bain patented in rapid succession his electric clock (1841), printing telegraph (1841), autographic telegraph (1843), fire alarm telegraph (1845), electric thermostat (1845), electric ship's log (1845), and electro-chemical automatic telegraph (1846). In 1848, Bain came to the United States to patent and introduce his telegraphic system and was taken up by Henry O'Reilly who was then engaged in a bitter contest with the owners of the Morse patent. He assisted Bain in procuring his patent, and lines were built all over the country on which the Bain instruments were employed. In 1852, after prolonged litigation, the Bain system was declared an infringement by the Circuit Court of Pennsylvania, although a few lines were in use up to 1860. Bain returned to England, and but little was afterwards heard of him as an inventor. He revisited America in 1863, but it was then evident that intemperance was rapidly undermining his bodily and mental powers. He died of paralysis in January, 1877, at an institution near Glasgow, of which he had been for some years an inmate. He was a man of striking personal appearance, of large frame, with a peculiarly massive head. His name will always be prominently associated with the history of electrical inventions. F. L. P.

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across a series of contact-points inserted in a non-conducting disc. With a seconds-beating clock, 60 contacts might thus be made each minute, one for each beat of the pendulum, and as many different secondary clocks in this manner operated by the primary clock. A modification of this plan was to operate a number of clocks simultaneously, and this differed from the first in employing a battery of a greater number of elements and placing a series of clocks in a single conductor. The secondary clocks consisted merely of the requisite train, the 'scape-wheel of which was driven step-by-step by the movements of the armature of a corresponding electro-magnet.

The second plan was to alternately complete a circuit, by the operation of the primary clock, through two conductors including two electro-magnets. A single armature was applied to the two magnets and it was driven to-and-fro in unison with the movements of the circuit-closer of the primary clock. The movements of the armature were communicated to the secondary clock-work by driving pawls. For the purpose of driving a number of clocks in this manner, it was proposed to cause the movements of the first armature to complete the circuit for the next clock and so on through as many clocks as the duration of the contacts of the circuit-closer would permit.

The winding of a series of mechanical clocks was accomplished by automatically completing a circuit with each clock at a predetermined time, and this circuit remained complete for say a minute. The winding magnet of the clock was thus vitalized and its armature driven forward. The reactive pressure of a gun-lock spring caused a bar carrying driving pawls to be driven to-and-fro. The pawls engaged the teeth of ratchet wheels upon the main-spring axis of the going and of the striking trains and thus the clock was wound.

This patent of 1841, contains also a description of a device for setting the clocks to indicate correct time, in one instance by prongs engaging a pin moving with the minute-hand arbor, and another instance by means of an electro-magnet the armature of which moves two clips working upon pivots attached to the front plate of the clock. When the magnet is vitalized the clips grasp the minute-hand, provided it has not deviated more than a minute from the regulating clock, and set it in exact time therewith. This last feature has been extensively adopted in a modern system of synchronizing to which we shall have occasion to refer hereafter.

Although the name of Barwise is associated in this patent with that of Bain, the latter was doubtless the real originator of all the essential features of the invention.

Later in 1841, Bain in conjunction with Lieut. Thomas Wright was granted another patent for "certain applications of electricity to the controlling of railway trains, the giving of signals, printing telegraphs and the actuating of clocks," but the application to clocks was in this instance of minor importance.

About 1843, Mr. Bain constructed an electric clock which was operated by currents derived from two plates, a zinc and a copper or a carbon plate, buried in the earth. These plates constituted an earth battery. Upon the pendulum bob there was placed a helix of insulated wire, and confronting this upon opposite sides were placed permanent magnets. A circuit controlling device completes the connection of the earth battery through the helix when the pendulum is near one limit of its vibration and interrupts the same when near the other limit. The helix when thus in circuit is attracted by one magnet and repelled by the other. Upon the interruption of the current the pendulum oscillates in the opposite direction.

Figure 1 illustrates such an organization. The two earth-battery plates are represented at M and N, and these are periodically connected with each other through a conductor L by the operation of the pendulum. The pendulum rod *a* is suspended by a spring a^1 and at its lower end there is carried a coil C of insulated wire. This coil is intended to vibrate between the poles of permanent magnets N S. These magnets have opposite poles confronting each other so that when a current of electricity tra-

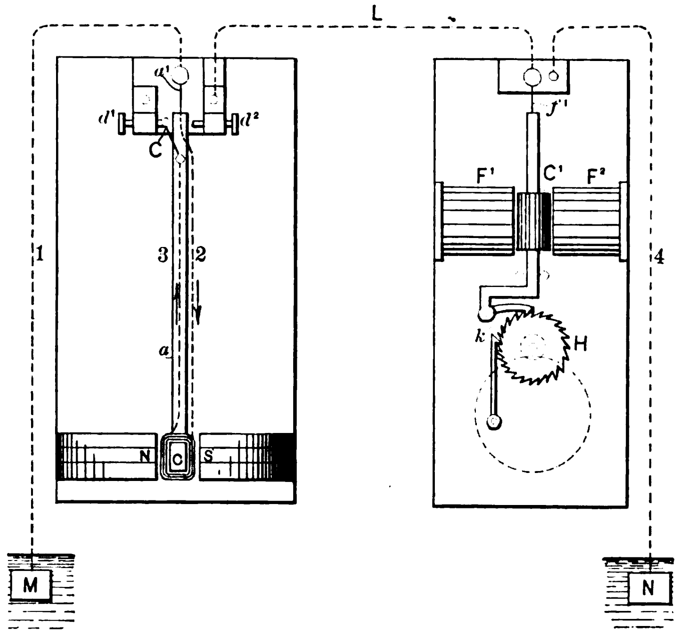

FIGURE 1.

verses the same from the earth-battery the coil will be impelled, in this instance, toward the right hand, both by reason of the repulsion exerted by the poles upon the left hand and the attraction of the poles upon the right hand. For the purpose of completing and interrupting the circuit, a small metallic ball *c* is pivoted to the pendulum rod, in such a manner that it is free to vibrate from side to side. Two insulated contact-stops d^1 and d^2 are supplied to the ball. When the pendulum swings to the left the ball will fall against the stop d^2, and when it swings to the right it will fall against the stop d^1. A conductor 1, leads from the plate M to the suspension spring a^1, and this spring is connected through an insulated conductor 2 with the coil C, and through this coil by a conductor 3 with the contact ball *c*. The conductor L leads from the contact-stop d^2 to a secondary movement. This consists of a coil of insulated wire C^1 placed axially between two confronting compound permanent magnets F^1 and F^2. The coil is suspended by two insulated springs, one only appearing in the figure at f^1.

The two springs are connected with each other through the coil C^1. The line L leads to one of the springs, while the other is connected by a conductor, 4, with the earth plate N. When, therefore, the battery circuit is completed by the movement of the pendulum *a*, a current will be transmitted through the coil C^1, and this will be impelled from one magnet between the poles of the other. Upon the interruption of the current the tension of the springs combine with the force of gravity to swing the coil in the opposite direction. A driving pawl, *h*, is caused by the to-and-fro movements of the coil C^1 to advance a wheel, H, and to thus actuate a clock train.

The compound magnets which appear in this instance each consists of a cylindrical series of permanent magnets surrounding a central core, and the coil, when it swings, passes outside the latter and within the circle of the poles of the former.

Such a clock Mr. Bain constructed and placed in the house of Mr. Finlaison in 1844. It contained but three small wheels, and, of course, required no spring or weight, being impelled by the currents derived in the manner stated. It is reported to have kept perfect time.

Another of these clocks, which Mr. Bain placed at his manufactory, was constructed to extinguish the light which

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illuminated the dial, at a predetermined time. The clocks of this description were usually enclosed in an oak case about 4½ feet high and 16 inches wide. They were furnished with second, minute and hour hands.

In a patent taken out by Mr. Bain this same year (1843) several different methods of operating clocks upon this principle, by currents derived from earth batteries are described, and the clocks which he introduced into public use appear to have been, for the most part, constructed in accordance with the description contained in this patent. A contemporary writer, John Gray, refers to these clocks as follows:

"When Mr. Bain, the patentee, first introduced this wonderful invention into the city of Edinburgh, I at once gave him an order for an electric clock with instructions to make me, if possible, a particularly good one. The accuracy of its time-keeping qualities may be judged by the fact that it goes correctly within about five minutes a year; that from the 9th of January to the 15th of February during the present year (1843) it has neither gained or lost a single second."

In 1845, Mr. Bain proposed to render a clock self-operative by causing a slight impulse to be repeatedly given to the pendulum. The movements of the pendulum control the circuit-connections of an electro-magnet and the armature-lever of the magnet controls an impulse-lever which is employed for giving the maintaining impulses to the pendulum. In a patent granted to Mr. Bain in 1845, the clocks are described as being so constructed that the current will be automatically interrupted when the vibrations of the pendulum have increased beyond a prescribed limit. The current is then practically withheld until the vibrations are reduced to the required standard.

Mr. Bain's attention being directed at this time more particularly to his electro-telegraphic inventions he did not find time to introduce his clocks into extensive public use although he always regarded the invention as a valuable one, and those clocks which he did put into use gave great satisfaction.

After about 6 years of practical work in manufacturing and testing electrical clocks, Mr. Bain endeavored to operate the clocks by means of permanently magnetized balance-wheels. Such wheels were driven to and fro by alternating currents transmitted through hollow coils of insulated wire within which the balance-wheel passed. The system is very similar to one proposed by other inventors in connection with vibrating pendulums many years later. The same idea was also applied by him to the winding of clocks constructed with springs or weights.

Mr. Bain evidently fully realized the desirability of providing some means for periodically setting all clocks, whether electrical or mechanical, that they might indicate correct time uniformly, for in 1847 he had developed no less than 3 entirely new and distinct methods of "setting to time, clocks and time-keepers." The first consisted of a simple device acting upon the minute-hand and operated by the action of an electro-magnet. The necessary electric current was derived from a thermo-electric pile acted upon, at a particular moment, by the rays of the sun passing through a slotted plate or through a lens. In this ingenious suggestion we find a recurrence to the principle of the sun dial as a means for obtaining correct time. In the second device a thermometrical circuit-closer, likewise acted upon by the sun's rays, was employed, and the third consisted of a rubber-ball released at the proper moment and a circuit-closer for operating the correcting device.

Mr. Bain's inventive genius was not by any means confined to the perfecting of electric clocks nor electric telegraphs, for during the years 1841–'47 he invented improvements in electric railway signals, telegraph line insulators, ship's logs, and musical instruments.

Several other inventors in the field of electric clocks appeared at about this time, and among them one or two Americans. The results of their labors we shall consider hereafter. (*To be continued.*)

INSTRUCTIONS FOR USING HARD-DRAWN COPPER WIRE.

Experience in the use of hard-drawn copper wire has demonstrated the fact that its durability is considerably lessened by the ordinary handling which galvanized iron wire receives in line construction. In order to avoid the damage arising from careless treatment the following instructions have been issued to linemen employed by the Baltimore & Ohio Telegraph Company:—

The hard-drawn copper wire used by this company, while possessing sufficient hardness and tenacity for its legitimate use, will not stand the rough handling to which iron wire may be subjected without injury. In order, therefore, that danger of bruising or marring it may be avoided, while in transit or being strung, the following directions must be complied with:

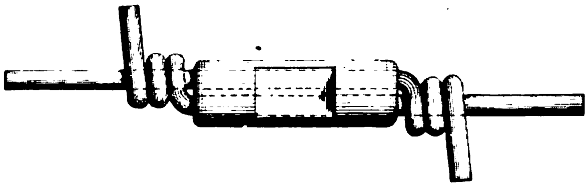
Every coil should be examined before the sacking is removed. In case the covering is frayed or torn, the coil should be closely inspected to see that it has not been cut or marred from the same cause that injured the sacking. In case the wire is found to have sustained injury, the coil must not be used unless the injured portion can be easily cut out.

Coils of copper wire should never be thrown from a moving train.

While unreeling the wire, great care must be taken to avoid twists and kinks. Whenever a kink is found it must be cut out, and a good splice made. This also applies to splits or indentation of any kind.

In tying the wire to the insulator, the wire should not be tied so as to touch the glass. The tie-wire should first be put entirely around the glass, one twist made in it, then the line-wire brought up and the two ends of the tie-wire twisted around it, with at least five turns, thus leaving the line-wire without bends or kinks. When done, the projecting ends must be twisted off, using the pinching portion of the Helvin grip for this purpose.

Care should be taken that the hard-drawn wire be not stretched as tightly as iron wire under like conditions, that it may not be broken by contraction in cold weather.



The Helvin Splice.

Hard-drawn copper wire must always be joined with the Helvin splice, whether in constructing new lines, or in repairing breaks upon finished wires. No excuse will be accepted for the use of any other splice. Linemen must always carry with them a plentiful supply of the couplings.

Splices must be made in strict accordance with the following directions.

Place the brass coupling in the "grip" or clamp, and secure it by means of the catch at the ends of the handles. Run the two ends of the wires to be spliced through the holes in the coupling, letting each project about five inches. Then, with the unemployed hand (pliers must not be used), wind each end closely around the wire as it enters the coupling, taking particular pains to see that the first turn is close to the coupling, that each turn fits closely to the straight wire, and that at least five turns are made. When this is done, put a little powdered rosin on the two wires where they enter the coupling at each end, still keeping the grip upon the splice. Then solder quickly with soft wire-solder. Finally, when cold, break off (do not cut) the projecting ends of the wires. Pliers, vises, or "holdfasts" must never be used on hard-drawn copper wire. Linemen found using them will be promptly dismissed.

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THE PROBLEM OF THE ELECTRIC RAILWAY.

BY CHARLES G. CURTIS.

It would be very difficult for an outsider, not an electrician, to form any idea of the feasibility or probable economy of propelling the elevated railroad trains by electricity, unless he had given that subject and particular problem a great deal of attention and calculation, without being influenced by the "claims" of non-expert parties. The difficulty of forming a correct conclusion has been much increased by the fact that nearly all the public have heard on the subject, has been the occasional announcements of tests by independent parties, each of whom has declared its exclusive ability to propel cars by electricity, by reason of certain alleged improvements invented and said to have been patented by them, which made it practically possible, and also by reason of the fact that they own, or would own the only ground patent on the subject; when, as a matter of fact, there have been no such improvements made (of great consequence), no such controlling patents have issued, and the only "ground" patent is still in the Patent Office.

This patent was awarded to Mr. S. D. Field last summer, after a protracted litigation in the Patent Office with Mr. Edison and Dr. Siemens, and will shortly issue to Mr. Field, unless it is put in interference with a new applicant swearing thathe made the invention before Field did in 1879. It will cover,—if it can be sustained broadly, which is doubtful,—every electric railway in which the electric current is generated by a *stationary dynamo-electric generator* and conveyed to the moving car through the rails of the track over which it travels, or through other special conductors laid parallel to the track, with which the car makes a constant traveling connection. This is the only feasible way at present to propel cars by electricity, and is the plan on which it is proposed to run the elevated railway trains.

There has been the usual amount of assertion by certain parties claiming to have greatly improved electric railways, especially as regards the efficiency of the motors, the use of currents of low electromotive force, etc., and to own the only controlling patents on the subject, etc., without any discoverable foundation. Four or five years ago Mr. Edison built an electric railway at Menlo Park about two miles long, upon which many prople have since ridden, showing that it was perfectly possible and even economical to propel one or more trains upon the same track, the current dividing itself between the trains in multiple arc, precisely as the lamps are supplied in the *multiple arc system*, which has been so well developed by the Edison Electric Light Company. His generator was a first rate dynamo-machine, his motor another dynamo and therefore equally efficient, and except in mechanical construction of the track and locomotive, every electric railway built in this country since 1880 has been substantially the same thing, with only slight changes suggested at that time, which have not resulted in any material increase in the efficiency, and have not even been patented. The step from the present electric railways to a complete elevated railroad system as proposed, working uniformly and reliably is not a question of patents or improved motors, but of bringing to bear upon the problem the very best electrical and mechanical engineering talent available.

The advantage of electricity over steam that first suggests itself is the saving in coal, but of course its comparative importance cannot be realized without knowing the total cost of operating the roads. The coal saved is easily calculated by comparing the pounds of coal now consumed in the locomotives with what would be required to produce the same horse-power in stationary engines, and allowing for a proper loss in transmission. For this, we will not start with the much-quoted figures given by London *Engineering*, as the Elevated Railroad Co's. do not pay for their coal at that rate. It will be better to base the comparison upon the quantity of coal actually consumed by these locomotives. Each locomotive is officially stated to burn about 40 lbs. of coal per mile run, at a mean speed of 12.5 miles per hour, which is at the rate of 500 lbs. per hour. It moves an average load throughout the day of about 170,000 lbs. at this speed, equal to 1,100 feet per minute. Applying a coefficient traction of .004 (it would probably be a little less with such good rolling stock), this becomes 680 pounds moved 1,100 feet per minute, equal to 23 h. p., and costing 500 lbs. of coal per hour; or about 22 pounds an hour per h. p. This enormous figure includes everything, waste, reserve, switch engines, etc., and it also includes warming the trains, but the latter service could not amount throughout the year to more than one-tenth of the whole coal, and therefore to obtain the necessary power the company has at present to pay for at least 19 pounds of coal per h. p. hour. Large stationary engines can do it for 2.5 pounds, but the engines and boilers that will be used, will probably, as they always do in general practice, require about 3 pounds, including every waste, but certainly not more. Consequently, if no power were lost in the double conversion between the stationary engine and the driving wheels of the electric locomotives, the actual saving in fuel would be over five-sixths of what is now used. But as such a loss is of course unavoidable, the fuel question resolves itself into:—How much can the electric locomotives be expected to return of the original power put into the stationary generating dynamos? To answer this involves a clear understanding of how an electric motor operates efficiently to convert the current into mechanical work.

Every scientist now knows that a dynamo-electric machine is almost *perfectly efficient;* that is, it will convert from 90-95 per cent. of the power applied to it into electrical energy or current, only 10 per cent. being ever needfully lost. The reason of this is quite clear when we consider that the resistance the machine offers to rotation, which is what absorbs the driving power, is *due to* and *produced by* the current actually generated, and consequently is the equivalent of the current, less of course the loss of from 5-10 per cent. by friction, etc. In other words, if the dynamo, though running, is not generating any current (when the circuit is open, for example), it requires no power to drive it; if generating less than its full capacity, it requires proportionately less power. It is also well settled now, as many electricians had predicted, that the same dynamo-machine will work equally well as a motor; that is, re-convert the current passed through it into mechanical energy; and by combining two such machines it has been assumed that power may be transmitted electrically by turning it first into current and then back into power, with as little loss in the second conversion as in the first. Theoretically this is true, but in practice the same conditions which make electrical transmission most desirable, especially for long distances, also make it impracticable to get as good a result from the motor as from the dynamo; a certain amount of the current being necessarily *lost in heat* in the circuit; though the dynamo can always be made to yield at least 90 per cent. of the power expended upon it. How much this loss will amount to in any given case can only be found by knowing how an electric motor operates, and it would be very difficult, as the matter now stands, for any one unfamiliar with the subject to get at the true theory of its operation. It seems to be generally supposed, even among some of the most eminent electricians, that the loss in the conveying conductors, due to heat, depends only upon their resistance—that is, their resistance, as compared with the resistance in the motor and the dynamo, precisely as in an electric-lighting system—and that, therefore, to transmit power efficiently is only a question of size of conductors. As a matter of fact, large conductors are necessary in practice to carry much power, where currents of low pressure must be employed, but their size does not affect the *percentage* of current-energy in circuit reconverted into power by the electric motor. On the contrary, the efficiency of transmission has nothing to do with either the

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resistance of the conductors or the particular kind of motor employed, but it depends entirely upon the *opposing* or *counter-electromotive* force set up by the motor when running; and this in turn is proportional to its superiority as a dynamo. There may be other points about a well-constructed motor which adapt it to particular conditions, such as lightness, shape, etc.; but as far as efficiency is concerned, it makes no difference how it is made, whether of an Edison type, or a Gramme type, or any other type. So long as it generates a counter E. M. F. equal to a certain fraction of the direct E. M. F., it necessarily has a converting efficiency represented by that fraction; and the best machine yet produced to "generate electro-motive force" (with the lowest speed, of course), is the best dynamo machine. For this reason the best dynamo machine "reversed" makes the best possible motor, and as the dynamo cannot be much improved in this respect, it is not very probable that the motor has been or will be—notwithstanding the extravagant assertions of certain inventors who have got many thousand dollars from capitalists on the strength of their statements to the contrary. When an electric motor is running, it necessarily, like an electrolytic couple or storage battery being charged, acts like a "reversed" dynamo, and tends to set up a more or less strong opposing current, called a *counter-electromotive force*, and it is the relative strength of this counter E. M. F., compared with the direct E. M. F. of the generating dynamo, that determines what fraction of the whole current in circuit is converted into work by the motor. If the counter E. M. F. be half the direct, the efficiency of the motor will be 50 per cent. If the counter be only 25 per cent. of the direct, the efficiency will be only 25 per cent.; if 75 per cent., the efficiency will be 75 per cent., and if the counter equal the direct, the efficiency will be 100 per cent. or perfect, which in practice is of course impossible. This is true, entirely irrespective of the *resistances* of either the dynamo, the conductors, or the motor. The generating dynamo machine, if ordinarily good, converts at least 90 per cent. of its driving power into circuit current. Of this 90 per cent. the fraction re-transformed into work by the motor is exactly equal to the ratio between the two electro-motive forces, if we deduct from this ratio losses in the motor aggregating at most 10 per cent. due to friction, Foucault currents, etc., which are equal to the corresponding losses of 10 per cent. in the dynamo. In fact, to ascertain the efficiency of any good motor, it is only necessary to measure these two electromotive forces by a galvanometer. These are all the losses that can possibly occur. Hence, with a counter of say 90 per cent., the net efficiency of the double conversion would be 90 per cent. of 90 per cent., or 81 per cent., less 10 per cent. loss in the motor, or about 73 per cent. In other words, the loss between the stationary engines and the track would be about 27 per cent. The very satisfactory efficiency of 73 per cent., and even more, could thus be had in practice, were it not for the fact that the counter E. M. F. reacts directly upon the generating dynamo. Its effect is just like that of so much extra resistance introduced into the circuit. It more or less neutralizes the direct E. M. F., causing the generator to produce just so much less electric current; but without affecting its efficiency, because at the same time the generator requires just so much less power to drive it. If the strength of the counter E. M. F. is carried too far, it is like interposing a very high resistance in circuit, the consequence being that the generator produces practically no current, and no power is transmitted. We know that if we double the resistance in a dynamo circuit, keeping its electromotive force constant, the dynamo generates only half as much energy in the form of current. In exactly the same way a counter E. M. F. of one-half in circuit reacts on the generating dynamo, causing it to generate only half as much current. Thus we see that increasing the counter E. M. F. results in two effects: first, it reduces the amount of current generated by the dynamo; and second, it causes the motor to convert a larger fraction of what remains into work. If the counter be low, the current is strong, but the motor's efficiency is low. On the other hand, if the counter be high, the current is low, but the motor's efficiency is high. The question then suggests itself whether these two things balance each other, or whether there is a certain relative counter E. M. F. which the motor will be giving out its maximum work (it being assumed that the direct E. M. F., being limited, remains constant). The fact is, that the motor will be doing its maximum work when the counter is half the direct, and it is interesting, as a matter of theory, to know why this is so, although in most actual cases a higher counter E. M. F. will probably be used. The work absorbed or the current developed by the generator we know to be equal to the direct E. M. F., multiplied by the current-strength; and the work done by the motor, as in electrolysis, to the counter E. M. F., multiplied by the current-strength. Since the current-strength falls as the counter E. M. F. rises, and *vice versa*, their product is greatest when each is half its maximum, or when the counter is 50 per cent. Hence a given system would be transmitting its maximum capacity when the motor is so worked that it generates a counter E. M. F., equal to 50 per cent. of the direct E. M. F. This fact is of no great importance in practice, however, for a higher counter will probably be employed, because the system will transmit almost as much power, while the efficiency is considerably raised. Besides this even with a counter of about 75 per cent. the dynamos would be giving as much current as they do in a light system, which is all they can carry, and with a counter as low as 50 per cent. the current would probably be strong enough to burn out or seriously overheat them.

The simplest way to estimate how high a counter E. M. F. will be economical in practice, is to compare the case with an incandescent light system. In a light system the current flowing through the conductors is controlled (mainly) by the lamps, and these are made of very high resistance compared with the rest of the circuit, in order that they may receive and turn into heat a large portion of the current in circuit. The Edison system, for example, is so proportioned that when all the lamps are turned on they form at least 80 per cent. of the total circuit-resistance, and they therefore utilize 80 per cent. of the whole current generated, the remaining 20 per cent. being lost as heat, mostly in the conductors. The reason for not making the conductors larger, so as to be of less resistance than 20 per cent. and thereby reduce the loss, is that the cost of the extra coal to sustain this loss is less than the interest on the increased cost of the larger copper conductors; on the other hand, if the conductors are made smaller and the loss exceeds 20 per cent., it is found that the extra power costs more than the increased interest on the copper conductors. Now, in a power system the motors take the place of the lamps, but as they are of very low resistance, they would draw an enormous current from the conductors, sufficient probably to burn out both motors and dynamos. This, however, is prevented by the counter electromotive force generated by the motors, which takes the place of the high resistance in the lamps, and regulates the supply of current exactly as does the lamp resistance in a light system. Consequently, in a well arranged system (as far as can be stated in general), with motors substituted for lights, the counter E. M. F. employed, together with the small resistance of the motors, should be the equivalent of the lamp resistance which it replaced, or a little less than 80 per cent. of the direct E. M. F., which would yield a net efficiency of about 65 per cent. Under these circumstances the dynamos would be giving the same current, and the motors would convert about the same current into power as the lamps were utilizing. Raising the counter above this point would cause the system to furnish less power, so that it would be necessary to increase the size of the plant. In any case, therefore, the efficiency of transmission must be offset by the size of motors, dynamos and conductors capable of delivering the

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required power. In some cases (water power, for example) efficiency is of little consequence, and cost of plant is everything; while in others, where a large amount of power is to be conveyed, and the original power is costly, cost of plant is insignificant compared with cost of original power, and under such conditions a net efficiency of transmission of over 65 per cent. would probably be more economical than a lower efficiency with a less expensive plant.

All this applies to cases where the motor, being stationary, is kept running at a *practically* constant speed, and when this is so, there is no doubt that an efficiency of 65 per cent. can be obtained. But where the speed of the motor is continually varying, as it will probably have to do in locomotives on the elevated railroad, which part of the time are just starting or moving at less than full speed, the average counter E. M. F. will be considerably reduced. If the motor be mechanically belted or geared to the driving wheels at an unchangeable rate, its speed, and, therefore, its counter E. M. F. will necessarily be very low when the train is started, and much below the maximum when the train is under part headway. It is true that the counter E. M. F. may be kept up when running slower by increasing the strength of the magnetic field, which will have the same effect as keeping up the speed, but then the field will require more current to feed it, and this current is an absolute loss.

The difficulty of the railway problem, therefore, consists in devising some form of *smooth-running, high speed, reliable mechanical* connection to the driving wheels, which will enable the motor to be run at a practically constant and high speed, whether the train be moving slow or fast. Two different rates of gearing at least will probably be required—one to obtain the requisite pull to start with, and the other when the train is moving at more than half speed. With such an arrangement a mean counter E. M. F. of perhaps 50 or 60 per cent. can be obtained on the elevated railroad, and this would give a net efficiency between the belts of the stationary engines and the driving wheels of the electric locomotives of from 40 to 50 per cent. Taking the lowest figure, and applying it as a coefficient of transmission to the original power, shows that 7.5 pounds of coal an hour in the stationary engine will furnish 1 h. p. on the track. As the present steam locomotives require over 19 pounds, this effects a saving of over 60 per cent of the coal.

Suppose that upon the second avenue line, for example, there are throughout the 24 hours on an average of 20 moving trains, each requiring 500 lbs. of coal an hour, or 240,000 lbs. for all for 24 hours, at $4 per gross ton, which amounts to about $436 per day. Sixty per cent. of this, or $260 per day, which is equal to 5 per cent. per annum on $1,898,000, would be saved in coal alone by the change.

It has been said that suitable electric locomotives would cost considerably less than the steam locomotives (which cost about $6,500 apiece), on account of their simplicity and absence of accurately fitted and steam working parts. Electric locomotives, however, have not been a regular machine-made gradually-developed article of manufacture for 20 years and more, like steam locomotives, so that, in spite of their simplicity, which will certainly prevent them from wearing out anything like so rapidly, it will be safer to assume that the cost of the first ones, including all necessary experimentation, will greatly exceed what would be supposed.

Whether the present firemen could safely be dispensed with in the electric locomotive, as has been suggested, is very questionable. Probably the passengers would prefer not to trust their lives to a single man in the engine any more or as much as to a single pilot at the wheel of an East River ferry-boat.

To transform the steam equipment of the elevated roads into an electrical equipment is now beyond a doubt a possible thing; but to make it equally efficient and reliable, and to do it without interrupting the very important travel, or causing accident, will require the very best electro-mechanical engineering ability, or else a long period of slow development. It seems now as if the problem were likely to receive more of the latter.

THE EDISON SYSTEM OF UNDERGROUND CONDUCTORS.[1]

THE essential form of the conductors exhibited by this company is that of an iron tube containing one or more copper conductors insulated from each other and the enclosing iron tube, and having all remaining spaces in the latter filled with an extremely viscous, almost solid, insulating compound, which becomes fluid at a high temperature. This manufactured product is termed an "electric tube." These tubes are manufactured in fixed lengths, generally 20 feet. The conductors project from two inches to three inches beyond the end of the enclosing iron tube, and two lengths of electric tube are joined together by means of copper joints soldered to the projecting conductors, and so formed as to allow the expansion of the conductors to take place without injury or danger. Such joints are protected by a cast iron box completely enclosing them and securely fastened to the ends of the tubes enclosing the conductors. This box is then filled with the same compound as the tube and hermetically sealed.

The exhibit of this company showed the great range in the size and number of conductors which the fundamental form of cased conductor permits, and the great flexibility in making circuits of complicated ramifications, which is given by the plan of having joints at frequent intervals; and the methods of making these joints.

To illustrate the range in size, etc., samples of electric tubes were shown containing conductors varying in number and size, from a single round conductor 1·61 inch diameter, of 2,592,100 circular mills or 2·036 square inches sectional area, in an iron tube 2¼ inches outside diameter, to 271 wires No. 14 Brown & Sharpe gauge, of 4,100 circular mills or ·00322 square inch sectional area, in an iron pipe 3¼ inches outside diameter.

To show the manner in which circuits of a complicated character may be made with this form of conductor, circuits such as those used for incandescent lighting on a large scale, having a large number of derived circuits with conductors of widely differing sizes, there was exhibited a portion of an underground circuit such as is used in T. A. Edison's 3-conductor system of incandescent lighting—a system using tubes, of which the cross-section is shown by figure 1.

This exhibit consisted of, first: a "junction safety catch box." This is a large round box the top of which is flush with the surface of the street; it is provided with a loose outside cover, and a lighter inside cover bolted down to make a water-tight joint with the box; these being removed, disclose the internal electrical connections in a readily accessible position, six inches below the surface of the street. The central portion of the box is occupied by the "pole pieces," consisting of as many rings as there are conductors in the system (in this instance three), each ring having as many radial projections as there are tubes entering the box (in this instance six), these projections, which are symmetrically arranged as regards polarity, are all brought to the same level at their extremities and terminate in plane, polished, gold-plated surfaces one inch square, which are arranged equidistant from each other in a circle around the centre of the box. Each of these surfaces has a tapped hole in the centre.

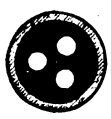

FIGURE 1.

In a circle outside the pole pieces are as many "safety catch joints" as there are conductors entering the box (in

1. Statement furnished by the Edison Electric Tube Company, and edited by the Board of Examiners of the Electrical Exhibition of the Franklin Institute. From the *Journal of the Franklin Institute* [*Supplement*].

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this instance 18); these safety catch joints are arranged radially opposite the extremities of the projection of the pole pieces; each consists of a copper or composition piece, which has a copper rod soldered into it, projecting about eight inches downwards into the body of the box, the upper end of the composition or copper piece terminating in a plane, inch-square, gold-plated surface, the same as those on the pole pieces. These surfaces of the safety catch joints are on the same level as the similar surfaces on the pole pieces, and radially opposite and equidistant from them.

Two feet below the top of the box (that is, the surface of the ground), the electric tubes (in this instance seven) enter the box and are rigidly attached to it, the joint being made water-tight. The pole pieces and the safety catch joints are all insulated from each other, but rigidly attached to a support rising in the centre from the bottom of the box.

Flexible copper cables join each conductor, of each tube, with one of the copper rods which project downwards from the safety catch joints, so that by means of flat safety catches placed across from the safety catch joints to the corresponding projections of the pole pieces, all conductors of like polarity are joined together at this point with a safety catch in each circuit in a readily accessible position, where it can easily be removed or replaced. Such a box equalizes the electromotive force at that point of all lines entering it, or if one of the tubes is a feeder, that is, runs back to the dynamos, the box is a distributing point for several circuits which may or may not be brought together again at some other place.

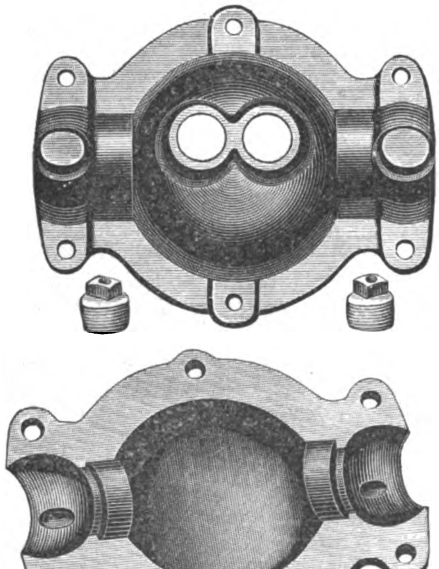

FIGURE 2.

The conductors in the tubes entering this box may be of any size to suit the requirements of the different circuits. The circuits shown entering this box vary from 350,000 circular mills to 133,000 circular mills area of conductor, and are arranged to show how they may be laid, bent in different degrees to right or left, joining each other at their extremities; crossing each other and joined together at the crossing; joining other circuits at any point in the length of the latter; reduced in size at any point of their own lengths, and having derived circuits of any size taken from them at any point of their own lengths; and having all these varied connections of different sized conductors made by means of a comparatively small number of standard patterns of connecting joints, boxes covering the joints, and ball clamps attaching the boxes to the iron tube enclosing the conductors.

The ball clamps, in connection with the boxes, are essential features of all underground conductors of this company's exhibit.

Figures 2, 3 and 4 illustrate the forms of these parts and the manner in which they are used.

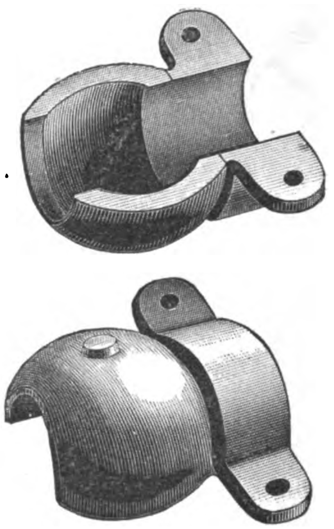

FIGURE 3.

Figure 2 shows the top and bottom halves of a "coupling box," a 3-conductor system, and figure 3 a "ball clamp," whilst figure 4 shows the bottom half of the same coupling box with tubes and ball clamps in place and joints connected. The two parts of the ball clamp being bolted together on the tube are thus securely clamped to it; the hemispherical parts come together to make a sphere, which fits the spherical socket in the nozzle of the box; the two together thus form a ball and socket joint, allowing free angular movement of the tube in any direction, but preventing longitudinal movement of the box on the tube. The angular movement allowed by the ball and socket is limited to any amount in any direction, by providing a rib inside the box (either separate as in figure 11, or forming the inside opening of the ball-socket of the box, as in figure 2) of such a form, that when the extreme amount of angular movement to be allowed in any one direction is obtained, the tube projecting into the box through the ball clamp comes in contact with this rib, thus stopping any further movement in this direction.

The box is made of such size and form that when the tubes have the extreme angular movement allowed there is still ample space between the joint and the box to prevent the two coming in contact. Rotary movement of the box on the tube is prevented by means of the small lug on the

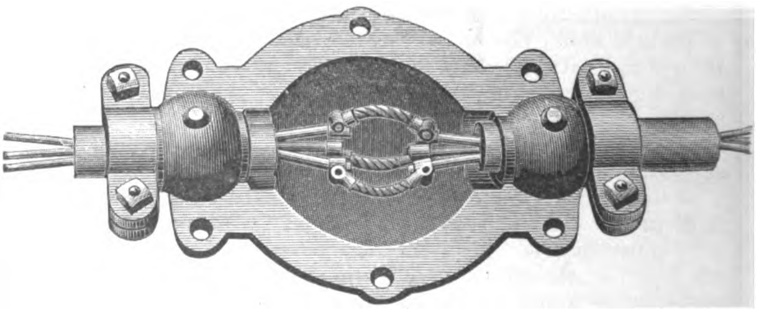

FIGURE 4.

ball of the clamp which loosely fits sidewise, the slot shown in the socket of the box, the slot being sufficiently elongated

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lengthwise that the lug may have free play in that direction within the limit of angular deviation allowed.

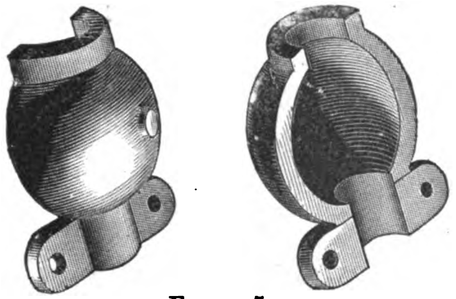

FIGURE 5.

The limiting rib inside the box is made to give the angular movement allowed, when the largest size of iron tube that will go into the box is used, but any smaller iron tube may be used in this box (as, for example, in reducing the size of the conductor at this point) by means of a ball clamp, of the form shown in figure 5, with a ball to fit the box, but with a smaller semi-cylindrical groove in each half to fit the smaller iron tube; this clamp has in addition, as shown, a semi-cylindrical ring concentric with the groove cast on the ball of each half; the two, when the two halves are clamped together on the iron pipe, forming a cylinder projecting into the box, of the same outside diameter as the largest iron tube that will go in the box; this projection on the clamp striking against the limiting rib inside the box, limits the angular movement of the smaller iron tube to the same amount as when the largest size of iron tube that will go in the box is used. Therefore the ball clamp and box, as described, whilst making the iron envelope of the conductors mechanically continuous, and preventing rotary movement of the boxes on the tube; allow an angular deviation (in this case 1 to 10) in every direction, at each end of every box, which gives a degree of flexibility to the whole line (in this instance 11½ degrees at each joint) and at the same time renders it impossible that the joint should touch the box, with the extreme amount of angular deviation allowed. The ball clamp, modified as shown in figure 5, also permits the use in any box of any tube smaller than the largest that will go in the box, whilst preserving the same limit of angular movement.

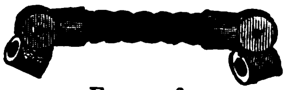

FIGURE 6.

The flexibility of the whole line thus obtained is necessary for rapid and cheap laying in streets, where, from the number of gas, water and other pipes, sewer-manholes, etc., it is impossible to run tubes in a straight line for any distance.

The joints for 3-conductor tubes consist of pieces of copper wire rope having cast or brazed on their ends suitably shaped composition sockets, in which are drilled holes to fit the size of copper conductor for which they are intended, and to which they are soldered in laying the line. The

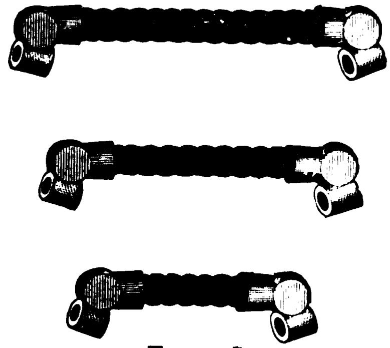

FIGURE 7.

joints necessary to obtain the results illustrated by the exhibit are: "Coupling joints," for connecting two tubes in a straight line (figure 6 shows the form of one piece, three such pieces being used for a complete joint); "90° elbow joints," for bending 90° to right or left, and "45° elbow joints," for bending 45° to right or left. Figure 7 shows three forms of pieces, different combinations of which will make all kinds of elbow joints. "Branch joints," by which, to any coupling joint in a line of any sized electric tube, may be attached a branch to one side, or one to each side, of any sizes not larger than the main line. Branches of sizes larger than the main line, being of rare occurrence, are not allowed for in the standard patterns for branches enumerated below, but, when required, may be made by a slight modification of the latter. Figure 8 shows three forms of pieces, different combinations of which will make,

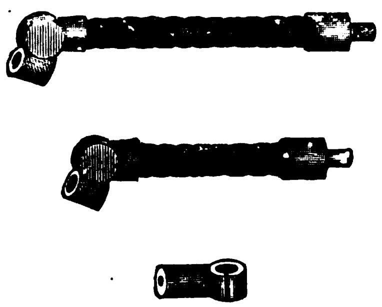

FIGURE 8.

to either or both sides of any coupling joint, branches of all sizes ordinarily required; a few of the largest sized branches require special patterns of modified forms, which are enumerated below. The form of socket of the coupling joint shown in figure 6 gives the copper wire rope of

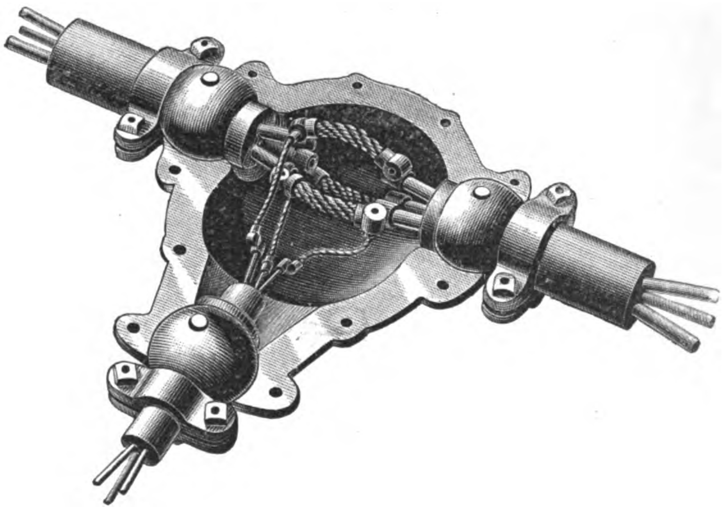

FIGURE 9.

the joint a bowed form when the joint is in place, to allow for the expansion of the conductors in each electric tube. The form of the joint when in place is seen in figure 4. Figure 6 shows that, in addition to the hole which fits the conductor, each coupling joint socket has another hole drilled in it; the male sockets on the ends of the branch joint pieces (see figure 8) fit these holes and are soldered in them in attaching a branch joint; the female sockets on the other ends of the branch joint pieces are drilled to fit the conductors of the electric tube used for the branch lines. Figure 9 shows a coupling joint, with a branch joint attached, in the bottom half of the box used for covering this kind of joint.

The 3-conductor system, so far as it is exhibited, has 21 different sizes of electric tubes, having conductors varying

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from 500,000 to 72,000 circular mills sectional area. The enclosing iron tubes are of five different sizes, varying from 2$\frac{3}{8}$ inches to 1$\frac{1}{16}$ inches outside diameter. All connections are made with 10 patterns of boxes, eight patterns of ball clamps, and patterns of 43 pieces for all joints ; of the latter, six patterns are required for coupling joints for all sizes, three of these patterns are also used for elbow joints, which require 15 patterns in addition, making 21 patterns for all varieties of all sizes of coupling and elbow joints. The remaining 22 patterns are for branch joints, and 12 of these will make any combination ordinarily required, the other 10 being for use in cases which rarely occur.

Electric tubes are exhibited cut away to show the internal construction, which consists in wrapping each copper conductor with a layer of insulating tape, and winding each taped conductor spirally with rope impregnated with insulation ; the pitch of this winding is large compared with the diameters of the rope used, so that the windings of the several conductors fit between each other when the conductors are placed together ; as many conductors as are to go in one tube, being so placed together, they are bound together by a final spiral winding of rope around them all, and the bundle of conductors thus formed being introduced into an iron tube, the process of manufacture is completed by filling the tube with insulating compound liquid, at high temperature, ready access being afforded the latter throughout the length of the tube, along the spiral paths formed by the rope-winding of the conductors.

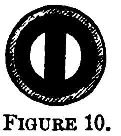

FIGURE 10.

Another variety of electric tube is illustrated by an exhibit of a complete set of sample tubes for the two-conductor system of incandescent lighting, and typical examples of the boxes, ball clamps and joints used with them. The conductors in this system vary from 1,639,890 circular mills, or 1·2879 square inches, sectional area in a tube 3½ inches outside diameter, to 33,015 circular mills, or 0·02593 square inches sectional area in a tube 1$\frac{1}{16}$ inches outside diameter, and, there being only two in a tube, economy of space in the latter is secured by making the conductors in the form of segments of circles, as seen in figure 10, which shows a cross section of one of these tubes. The joints for these tubes are of cast copper, the allowance at coupling joints for expansion of the conductors being given by making the joints with a U-shaped bend, projecting at right angles to the line of the tube, the section of the joint in the U being flattened to a paralellogram, long in comparison with its width, as is seen in figure 11, which shows a coupling joint for this system of tubes, with bottom half of coupling box. Holes are bored in all joints of the same form as the conductors for which they are intended, and to which they are soldered in laying. Boxes are exhibited with short tubes entering them, and joints connecting the latter, showing the forms assumed by different sizes and varieties of coupling elbow and branch, joints and boxes. Figure

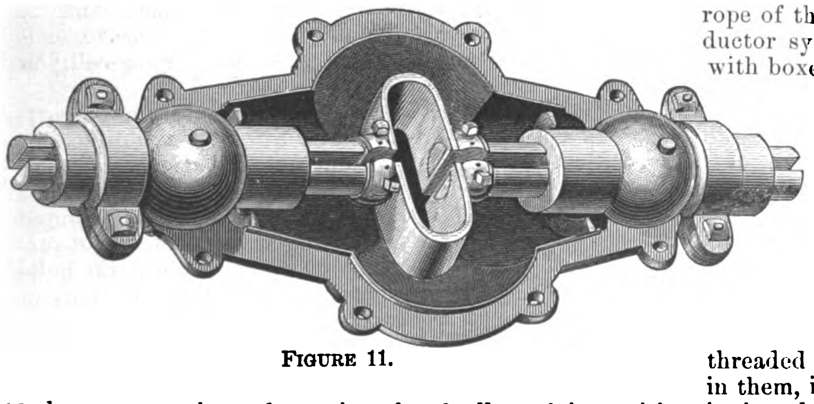

FIGURE 11.

12 shows one variety of one size of 90° elbow joint, with bottom half of elbow box.

In both the three and two conductor systems, boxes and joints are shown for use in in-door lines of these tubes. The flexibility of the line which is required for underground work, and which is given by the ball and socket connection of clamps and boxes is not necessary in in-door lines ; the boxes may therefore be smaller on this account, and also on account of the absence of the ball clamps, the

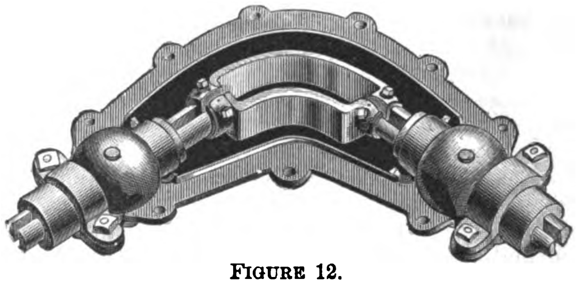

FIGURE 12.

mechanical continuity of the iron envelope of the conductors being secured in small space by means of a ring which is screwed on the threaded end of the iron pipe and fits in a groove cast in the neck of the box (which neck fits the iron tube) ; this box is made in halves, which are bolted together over the joint, the end of the tube, and the ring screwed on the latter.

Underground arc light circuits were illustrated by two exhibits showing the character of the tubes and joints and the method of taking loops to lamps. One showed tubes with two round conductors for a complete circuit in one tube.

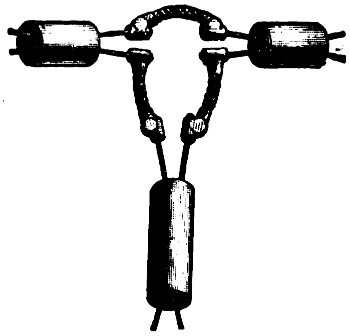

FIGURE 13.

Figure 13 shows this exhibit, and the method of making the joint so that, the branch tube being led off to a lamp or lamps, the two conductors of the branch form a loop of the main line. The second exhibit shows the case of a circuit completed by a line on another street. In this exhibit the main line tubes entering the box have only one conductor each, the conductor of each tube being joined to one of two conductors of the third tube, forming a loop from the main line of a single conductor. The joints are of wire rope of the same character as the joints for the three-conductor system. Ball clamps are used to connect tubes with boxes.

A distinct variety of electric tube is that designed for telegraphic and telephonic use. In this case, the conductors being large in number and small in size, instead of the spiral rope winding round each conductor, the insulating covering is continuous, and a rope winding is only used round the outside of a bundle of such wires. The wires are laid together regularly, on the basis of a hexagonal cross section for the bundle, and at each end are threaded through wooden screens which have holes drilled in them, in the same relative positions as the wires occupy in the tube. At one end of each tube, before being threaded through the screens, the wires are woven together so as to change the relative positions of the wires. This operation

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of weaving is simple and systematic, and the same for all tubes with the same number of wires, and is arranged on such a basis, that in conjunction with a systematic rotation of consecutive tubes, alternately to right and left, in the process of laying, it produces, in a series of long period, methodical changes in the relative positions of the wires in consecutive tubes, for the purpose of neutralizing the effects of induction. In making the joints of these tubes, wires threaded through corresponding holes in the screens are bent outwards and placed together in the same notch of a series of notched wooden slats, one for each layer of wires in the joint, which are built up one above the other, as the process of making the joint proceeds. When all the wires are so bent out, the ends are clipped off, leaving about one inch projecting through the wall of notched slats; the insulation is then slipped off the ends and each pair joined by a small sleeve, which is soldered to them to make the joint. In general, the joints of half the wires are made on one side and half on the other side of the box. Grooves are provided in the boxes into which they fit the wooden screens through which the wires are threaded, and the series of wooden slats built up in making the joint, holding these securely in place. By this method of making the joints, every joint of every wire, at intervals of 20 feet, is brought into a position in which it is readily accessible for purposes of testing, making connections, etc., without interfering with any other wire, so that at any such joint, loops or single service wires may be attached to any or all of the wires in the line. A line of this character, containing 37 wires was exhibited, with several consecutive boxes and joints to show the system of weaving wires in conjunction with alternate rotation of tubes. Such a line is adapted more particularly to telegraphic uses. Another box was exhibited, constructed with especial reference to the needs of telephone service, for which, in addition to trunk lines between stations, a number of wires are required for services in each block, and only run from the station to that block, thus giving a line between two stations a size decreasing gradually from each station to some point between them. The box exhibited, which showed a joint in a line of 217 wires, had a low turret rising from its upper half, the top of this turret was closed by a loose outside cover and an inside cover bolted down, and making a tight joint with the box by means of a rubber gasket; the whole being made water-tight by filling the space between the two covers, with the insulating compound. In every such box, along the face of a block, all those wires which are intended for use as services in that block, are bent upwards instead of outwards, in making the joint so that the joints of all such wires project upwards into the turret and are held in position by a wooden frame shown, whilst the joints of all other wires are made out to the sides at a lower level; this arrangement allows the box to be filled with insulating compound, covering all the wires and all joints, except the joints of those wires intended for use in that block, which latter joints project up above the surface of the compound, and on removing the cover of the turret are all immediately accessible at every box along the block, for attachment of services, to any or all of them. Tapped holes are provided around the turret on the level of the joints of service wires, into which service tubes may be screwed, if electric tubes are used, or brass nipples to which are soldered the lead covering, if lead covered wires are used for service connections.

This company also exhibits specimens of lead covered wires of small sizes, and a specimen of flexible heavy conductor for indoor use with large currents, consisting of copper wire rope, taped, wound and lead covered. They also exhibit specimens of insulating tape, in rolls of 125 feet, continuous length, varying in width from six inches to ¼ inch, and jars of the insulating compound used in the tubes and boxes.

COMMENTS BY THE EXAMINERS.

This system may be summed up as belonging to division "A a" of the Section's arrangement, or that in which the electrodes are permanently sealed. When any portion of an electrode is destroyed a new one is not introduced, but a new length of pipe is substituted, containing the necessary number of wires and attached at its extremities. The details are very fully given, and with the cuts render it unnecessary to repeat them. With a large stock of lengths and boxes and with trained workmen, the work of laying the conductors only a few inches below the surface of the streets would be comparatively rapid. While in the tentative stage of underground service this does not present the same amount of convenience as a system where wires may be introduced and removed at will; and presents the objection common to all "section" systems that the conducting capacity of the whole line is that of the most imperfect of splices made every 20 feet, yet it answers the demands upon it much better than those systems which require expensive and tedious derangements of the street in order to accomplish repairs. The seat of an accident to one of the wires of this system is located from the central office, on and between known streets. The manhole is opened and the safety catches first of all examined. The managers assert that the place of the break can then be so accurately located that the length containing it (usually about 20 feet) may be at once removed and replaced by another.

The telephone and telegraph, and the light and power wires are not enclosed in the same tube. The insulating material with which the boxes are filled is still flexible at 32° F., but brittle at 0° F.

The method of laying and tapping for private dwellings would seem to afford complete protection against lightning. The three-wire system which has been grafted upon the Edison conduit system effects a saving of 62 per cent. on that required for the two conductor system, in the copper necessary for conductors.

The light and power system are not adapted for use by various companies, independently, though the telephone and telegraph conduits might be so applied.

The details of this system have been so perfectly elaborated, that in view of the fact that no complete description of it has been heretofore made public, the examiners deemed the above full report desirable.

F. D. DE WOLSKI (Chairman),
PERSIFOR FRAZER,
LUTHER L. CHENEY,
} *Examiners of Section XVIII.*

ABSTRACTS AND EXTRACTS.

A NEW STORAGE BATTERY.[1]

BY EMILE REYNIER.

THE new electrical accumulator manufactory of Messrs. Blanc & Co., at Marly (Switzerland), is making its existence felt by putting on the market several perfected models, adapted to the diverse exigencies of the industrial applications of the storage battery. Among the most recent types, is a small zinc storage battery intended to replace the primary cells hitherto used for telegraphy, telephony, railway signals, call bells, etc.

The couple (see cut) bears an exterior resemblance to the ordinary Leclanché cell; and this resemblance extends to the cylindrical amalgamated zinc and porous cell, but ends there.

The positive electrode, placed in the interior compartment, is a sheet of peroxydized lead, folded in 3 directions longitudinally, pierced by numerous transverse slits, and rolled into a spiral; it is reinforced at its upper part by a diametrically placed cap or clamp of copper, surmounted by a screw-post for the connecting wire. The useful surface of the electrode is about 62 square inches; the holes with which it is pierced putting the interior portions in communication with the exterior.

The liquid is a solution of bisulphate of potash. This salt in crystals is placed in the central space left by the lead electrode.

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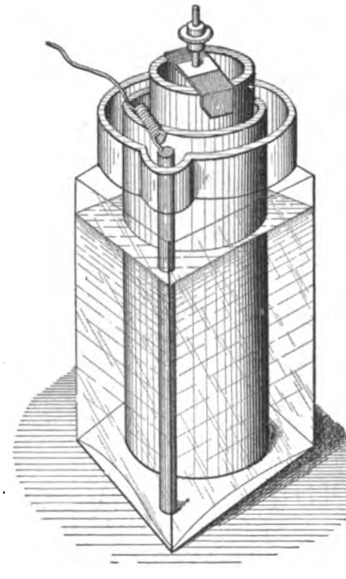
To put the battery in operation, it is only necessary to pour water into the 2 compartments. The acid salt dis-



solves gradually in the porous cell; it diffuses slowly and without great excess in the exterior compartment, where it dissolves the zinc when the circuit is closed. This couple operates like my ordinary zinc storage batteries, with this difference, that in this case the sulphuric acid is borrowed from the bisulphate of potash. The salt yields an equivalent of acid, the chemical reactions involve then, 2 equivalents of bisulphate.

The substitution of the bisulphate of potash for the free sulphuric acid, and the use of a porous cup, have for their objects the almost entire suppression of local action on the zinc.

	Small zinc accumulator.	Leclanché cell with 2 plates.
E — electro-motive force { initial, in volts	2.37	1.48
E — electro-motive force { in use, "	2.2	1.2
R — resistance, in ohms	0.4	1.1
Q — electro-chemical capacity, in coulombs	54,000	52,000
I — normal strength of working current, in ampères	1.	0.08
i — strength of charging current, in ampères	0.3	
EI — performance of work, in watts	2.2	0.12
QE — total work, in k g m	11,000	6,200
g. Length and breadth, in inches	3¼	3¼
Total height, in inches	7¼	7¼
Total weight, in lbs.	5	4¼

One may estimate from the above figures the value of the small zinc accumulator relatively to that of a Leclanché cell of the same size.

The table shows evidence of the superiority of the small zinc accumulator over the Leclanché cell; its electromotive force, its delivery, and its total work are greater, while its resistance is much smaller—a useful quality in all of its applications, but especially valuable when used on the carbon transmitters of telephone systems, for it renders the variations in the resistance of the transmitter more sensible, and in consequence augments the strength and clearness of the sounds transmitted.

In practice, one of these accumulators will fully replace two Leclanché cells of the same size. The retail price of both being about the same per cell, the substitution of the new system for the old will result in a saving of 50 per cent. on the cost of installation.

We shall see that the economy in maintenance is greater still.

The regeneration of the accumulators may be effected in two ways:

First.—By replacing the electrodes and exhausted liquid; it is necessary then to replace only 1 zinc instead of 2, a lead plate instead of the 4 agglomerated plates, and 150 grammes of bisulphate of potash instead of 200 grammes of sal ammoniac.

Second.—By passing through the cell, during 40 to 50 hours, a current of above .5 ampères, furnished by a dynamo machine. The expense of this work is, at the most, about 1-10th of 1 h. p. This method, being much more economical than the first, would be exclusively employed where the accumulator was used on a large scale for telegraphy and telephony.

The small zinc accumulator possesses a great elasticity of performance; it may either expend its charge in a few hours, or extend its work over a period of six months.

Under ordinary circumstances, the regeneration should be practiced at intervals of 3 months. As the electrodes will bear 100 chargings, the life of the accumulator will exceed 25 years.

For some time past it has been desired to replace the costly work of primary batteries by that of machines; but outside of central stations employing thousands of cells, the substitution is neither convenient nor economical. The use of accumulators, which allow of the division, the distribution, and the storage of the work of the machines, will remove all of these difficulties. Accumulators may be introduced without embarrassment to the staff, since they bring no other modification of the service than the employment of a lesser number of cells by one-half—and without any sacrifice to the owners, since the jars, zincs, and porous cells of the Leclanché system, both old and new styles, would be utilized. The latter consideration induced me to arrange the small zinc accumulator in the same size and shape as the Leclanché cell, which it is intended to replace.

A SCALE OF HARDNESS FOR METALS.

THE following is a scale of hardness in use in the laboratory of the Technical High School at Prague, composed of eighteen metallic substances, arranged in ascending order from the softest to the hardest:

1. Pure soft lead.
2. Pure tin.
3. Pure hard lead.
4. Pure annealed copper.
5. Cast fine copper.
6. Soft bearing metal (copper, 85; tin, 10; zinc, 5).
7. Cast iron (annealed).
8. Fibrous wrought iron.
9. Fine-grained light-gray cast iron.
10. Strengthened cast iron (melted with 10 per cent. of wrought turnings).
11. Soft ingot iron with 0.15 per cent. carbon (will not harden).
12. Steel, with 0.45 per cent. carbon (not hardened).
13. Steel, with 0.96 per cent. carbon (not hardened).
14. Crucible cast steel, hardened and tempered, blue.
15. Crucible steel, hardened and tempered, violet to orange-yellow.
16. Crucible steel, hardened and tempered, straw-yellow.
17. Hard bearing metal (copper, 83; zinc, 17).
18. Crucible steel, glass hard.

TEST FOR LUBRICATING OIL.

PLACE a single drop of the different kinds to be compared in line across the end of a piece of plate glass about 24 in. long, one end being placed 6 or 8 in. higher than the other, to form an inclined plane. The drops of oil run down this smooth plane in a race with each other. The quality of the oil for lubricating purposes is shown by the distance traveled, and the trace left by the drops. Thus, on the first day, sperm oil will be found in the rear, but it will in time overtake the rest, and retain its power of motion after other oils have dried up. A light bodied oil flows quickly, like water, but also dries, whereas what is needed is a good body compared with a limpid flow. Many oils have a good body, but have a tendency to gum, and will be distinctly shown upon the glass.—*Chemical Review.*

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ELECTRICAL ILLUMINATION IN MICROSCOPY.[1]

BY E. A. SCHULTZE.

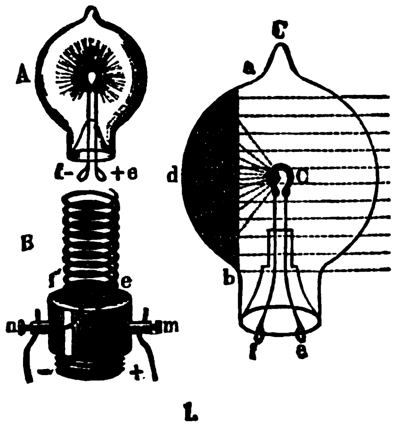
THIS subject has for some time had the attention of scientific men both in this country and in Europe. Among the first to note the advantages of the electric light in microscopical research, figures Dr. Henri Van Heurck, of Antwerp, a student who ranks as high in Belgium as does Mr. Edison in the United States. His investigation began, about ten years ago, with a trial of the effects of a galvanic battery on platinum, but the trial yielded no satisfactory results. He was the first to employ the Swan lamp for microscopical illumination, the experiment being made at the Paris Exposition. Shortly afterward, in November, 1881, with a view to greater progress in this work, Mr. Swan endeavored to manufacture the smallest possible lamps; and in the following January he constructed one which required only seven volts, or the power of four Bunsen elements, and sent it to Dr. Van Heurck. The latter carefully tested its usefulness, and he published the results in the Proceedings of the Belgian Society of Microscopists. In March, 1882, a committee of that Society visited him for the purpose of witnessing his methods and measuring their success. Before the end of that year he published in the Bulletin of the Society an extended article on the adaptability of electrical illumination to the microscope, in which he gives a theoretical explanation of the superiority of the electric light over all others, and much useful information, besides, regarding its practical working. He found that for the resolution of diatoms, as well as for all other work requiring objectives of high power, the light furnished by his electric lamp, when fed by a suitable battery, was better by far than any he had previously employed; also that an electro-motive force of six or seven volts amply suffices for all uses.

The views of Dr. Van Heurck are ably seconded by Dr. Theodor Stein, of Frankfort-on-the-Main, in an article contributed by him to the "Zeitschrift für Wissenschaftliche Mikroskopie," Vol. I., No. 2 (1884). I have made a digest of such parts as are material to my purpose, as follows:

"The electric light," says Dr. Stein, "has been in use many years for showing microscopic objects by projection upon a screen with the use of the magic lantern. With constant improvement in the manufacture of objectives, the discernment of fine structure was possible even by this method. But the excellence of the performance found its limit at a power of 80 diameters, a higher amplification seriously impairing definition.

"At the Electrical Exhibition in Munich, in 1882, trial was made of the advantage of electrical illumination in working with the compound microscope. The light furnished was found to be sufficient for the finest observation with objectives of the highest power, and to be free from the well-known disadvantages of other kinds of artificial light—the yellow ray and the heat ray. All possible preparations were examined, such as muscle, nerve, epithelia, bone, skin, bacteria, diatoms, etc. Especially surprising was the faultless picture of the red blood-corpuscles, to the correct showing of which a yellow light is particularly inimical. In the region of blue and violet, the spectrum of the light from an incandescence lamp is incomparably more intense than that of light from any other artificial source. In these observations light of different intensities was used, ranging between 16 and 60 candle-power, and was received by the substage mirror and was reflected thence upon the object.

"These experiments suggested to me, in the winter of 1882, the idea of setting aside the mirror, and placing the incandescence lamp beneath the stage for the direct illumination of the object. As no lamp small enough for the purpose was in existence, I requested Mr. C. H. F. Müller, of Hamburg, to make me some according to certain specifications which I gave him. At this time appeared in the Journal of the Royal Microscopical Society an article by C. H. Stearn, who, at a meeting of the Society, held January 10th, had exhibited a microscope furnished with electrical illumination. I again conferred with Mr. Müller; and I now have lamps, manufactured by him, which suit my purpose. Illustrated at A, figure 1, is a small lamp; at C, a larger one. Each consists of a glass globe, at the exact centre of which is a horse-shoe carbon supported by two platinum wires. The wires terminate outside the globe, in the eyes *f* and *e*. The neck of the lamp A is forced into the spiral spring B, and connection is made with the hooks f^1 and e^1. The spring presses the lamp upward, and thus brings about an intimate contact of the eyes *f* and *e* with the hooks f^1 and e^1. These hooks communicate with two conducting wires *m* and *n*, which are let into a hard-rubber screw. The screw itself is attached to the extremity of a jointed arm articulating with the microscope as shown in figure 2. To bring a lamp of the smaller size to a brilliant white heat, a current from two Bunsen or Grove elements 20 cm. high, is sufficient. The lamp C, figure 1,



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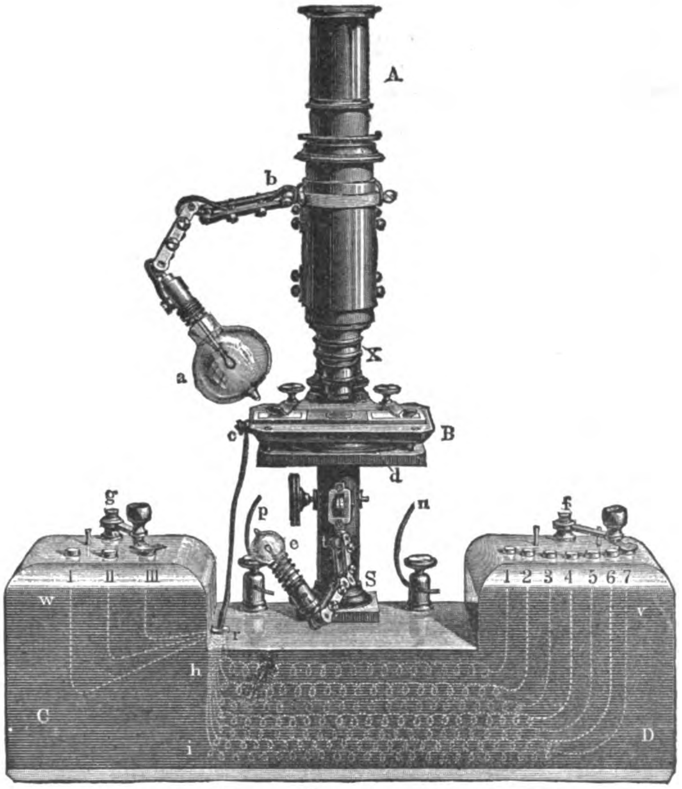

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1. *Journal of the New-York Microscopical Society.* Read Nov. 7th, 1884.

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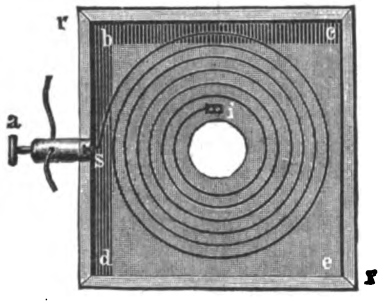
having a larger carbon, will require three elements. Should a stronger light in any direction be required, a part of the globe, as seen at *d*, figure 1, may be silvered on the outside so as to act as a reflector. For lamps to be used with low-power objectives, opal glass is preferable to common glass, as the light through it is less fatiguing to the eye.

"In figure 2 we see a small lamp, *e*, and a larger lamp, *a*, attached to an upright microscope. The foot, S, of the instrument is screwed to a wooden box, C D. For facile movement in every direction, both lamps are supported by arms furnished with ball-and-socket joints.

"The wires from the battery are fastened to the instrument by the binding-screws *p* and *n*. From the screw at *n* a concealed wire goes direct to the foot, S, of the stand, and beyond this point the microscope itself serves as a conductor communicating with the lamps *a* and *e*. The return wires are well insulated. That from the lamp *a* runs along the jointed arm *b*, then down the back of the stand and along the side of the stage to the support *c*, and thence into the box through the aperture *r*. That from the substage lamp runs along the jointed arm *t*, then behind the stand and by the side of the stage to *c*, and thence it accompanies the first wire. Besides these there is a third wire, also insulated, and passing downward, which is attached to the stage. Between *c* and *r* the three are bound together in one bundle. The communication between the binding-screw at *p* and the lower end of one or other of the three wires entering the box at the orifice *r*, takes place through an important subsidiary apparatus, the rheostat, and is regulated by means of the switches *g* and *f*. The switch *f* and the spiral german-silver wires, *v i h*, constitute the rheostat, by means of which the electric current can be strengthened or weakened at pleasure. The wires have different diameters, and thus oppose to the current differ-



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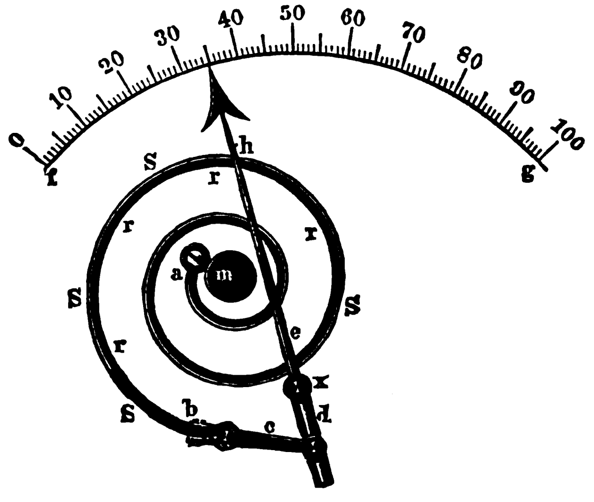
ent degrees of resistance. If a small battery of two elements be used, the rheostat is superfluous. But if a powerful battery be employed, the current will, unless subdued, be too strong for the lamps, and will destroy them.

"The operator begins work by sliding the switch *g* to the proper point. He will move it to the knob I if he wish to use the upper lamp, to the knob II if the lower, and to the knob III if he desire the current to traverse the stage, B, alone. Next, to adjust the current to the size of the lamp, the power of the objective, and the character of the object under investigation, he will first place the switch *f* on knob 1, and then will cautiously slide it to knobs 2, 3, 4, etc., until the required degree of illumination is obtained."

Dr. Stein next gives the construction of what he would call an "electrically-heated stage." Between the two plates of the stage is placed a platinum spiral, figure 3, which may be heated by the electric current so as to raise the temperature of an object under examination. The degree of the heat is easily controlled by the rheostat, and it may be measured by means of a spiral bimetallic thermometer. In the illustration, figure 4, *r* and S are ribbons of iron and brass, soldered together. The inner end, *a*, is screwed to the stage close to its opening, *m*. The free end, *b*, acts upon an index, *d*, which is pivoted at *x*, and whose point traverses the graduated arc *f g*.

The rest of the article treats, in a full and interesting manner, of the application of electrical illumination to photomicrography, and describes a form of stand especially



4.

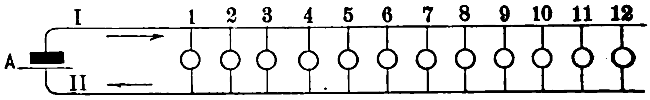
adapted to that department of microscopical work. The details cannot be given here. One or two facts, however, I must note,—the microscope has a vertical position instead of the usual horizontal one, and the illumination necessary for taking a most excellent photograph of *Pleurosigma augulatum* costs an electromotive power of only five volts.

Dr. Stein concludes his article with an expression of confident belief that the microscopist who has once employed the electric light for his researches, will thenceforward use no other.

EDISON'S THREE-WIRE SYSTEM OF ELECTRICAL DISTRIBUTION.[1]

BY H. M. PAUL.

THE three-wire or multiplex system of distributing currents for electric lighting over large areas, as devised and used by Edison[2], is highly ingenious, and effective in reducing the necessary size of the large copper conductors. The size of the conductor must be proportioned to the maximum number of lamps which it will ordinarily supply. This number being given, the size should be such that the resistance of the metallic part shall bear a fixed ratio to that of the lamp part of the circuit; and the value of this ratio will be determined by the condition that the additional running expense due to the resistance of the conductor shall equal the interest on its first cost, so far as this depends upon its cross-section.



TWO-WIRE SYSTEM.

In the two-wire system, A is the dynamo, which we will suppose to keep up a difference of potential of 100 volts between the conductors I and II. Across these are bridged 12 lamps of equal resistance, representing what would be, in practice, several hundred dwellings, factories, churches, theatres, etc.

The next figure shows Edison's three-wire modification of this. A and B are two dynamos coupled in series, with conductors I, II, and III leading out as shown. As A and B each keep up 100 volts, as before, the difference of potential between I and III will be 200 volts. The 12 lamps are

1. *Science*.
2. See U. S, Patent of T. A. Edison, No. 274,290, March 20, 1883.

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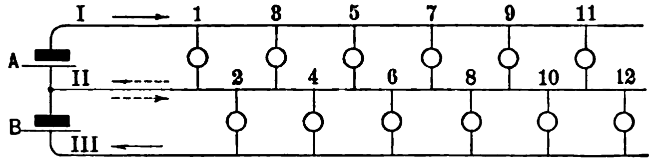
now, however, equally divided between the circuits I-II and II-III, connected as shown. If the resistance of the 6 odd-numbered lamps, 1-11, exactly equals that of the 6

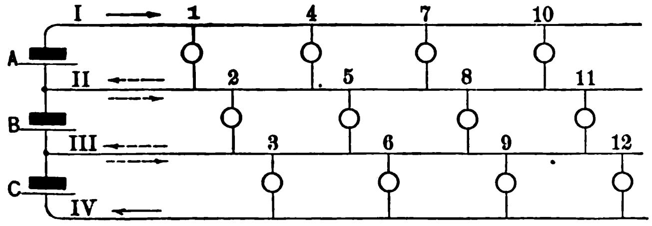


THREE-WIRE SYSTEM.

even-numbered, 2-12, and if A and B keep up the same difference of potential, no current will flow in II, between the dynamos and where the first lamp joins it. Suppose II to be cut, there will then be a single circuit through A and B, I and III, and the 12 lamps, as shown, with a difference of 200 volts in I and III. The resistance of the 12 lamps, as now arranged, will be four times what it was before, and hence only one-half as much current will flow through I and III. But each of the lamps will get just as much as before, and will shine the same. The conductors I and III, since the resistance is now four times as great, need only be one-fourth as heavy, according to our adopted principle. This is also proper as regards heating-effect in them, which, proportional to the square of the current, is now only one-fourth what it was before.

If this were all that was needed, we should now have the same amount of lighting done, and the conducting mains, which are the most expensive part of the plant, of only one-fourth their size and cost in the two-wire system, and with only the additional expense of another dynamo. Moreover, since the current is only one-half as much, these two dynamos, though giving the same potential as before, can be smaller. But on account of the difficulty in keeping an exact balance in the two sets of lamps, especially about the time of lighting up at twilight, it is necessary to introduce the third conductor from between the two dynamos, and then neither circuit can be exposed to a difference of potential greater than either dynamo is generating. Also, if the balance is not kept, a current through II, and a galvanometer, shows on which side the lamp resistance or the dynamo potential is in excess; and Edison restores the balance by variable resistances in the circuits of the field magnets, or, in some cases, by bringing an extra conductor from one or two large buildings, like factories, theatres, etc., when near by, so that they can, at will, be thrown into either circuit from the central station.

This middle wire need not, for most purposes, be so large as the other two; but, in the case of a breakdown of I or III, it will have to do equal work with the other, so that it is safer, simpler, and better to make them all of the same size. The cost, then, of conductors, is that of three wires, each of one-fourth the section of the two in the first case, or $\frac{3}{2} \times \frac{1}{4} = .375$, or a saving of 62.5 per cent.



FOUR-WIRE SYSTEM.

The four-wire system shows a still further reduction of expense. The law on which this percentage of economy proceeds, as far as cost of conductors is concerned, may be shown as follows, in units of the cost of the two-wire system:

For 2 wires, we have,	$\frac{2}{2}(\frac{1}{1})^2$	1.000
" 3 " " "	$\frac{3}{2}(\frac{1}{2})^2$	.375
" 4 " " "	$\frac{4}{2}(\frac{1}{3})^2$	.222
For 5 wires, we have,	$\frac{5}{2}(\frac{1}{4})^2$	.156
" 6 " " "	$\frac{6}{2}(\frac{1}{5})^2$	.120

A limit of economy or practicability, however, will soon be reached in the increased number of dynamos, the complexity of the system, and especially in keeping up an approximate balance between so many circuits. In practice, probably, the three-wire system, with its saving of .625 of the cost of the two-wire, will be found all-sufficient; except, perhaps, in the case of a long main through a large scattering district, when the four or five-wire plan might be preferable.

One other advantage, available in all these systems over the two-wire plan, is, that if needed for purposes of driving motors, or for large street lamps of higher resistance, a potential twice as high as the ordinary one is very simply available by connecting across from I to III, or three times as high from I to IV in the four-wire plan, etc.; and, no matter what the amount of such employment, it will not disturb the balance of the intermediate lower potential circuits.

In a recent number of the *American Engineer*,[3] Professor H. S. Carhart, referring to the Edison three-wire system, says: "It is evident that this arrangement does not secure the maximum economy corresponding to the results obtained for the most economical size of a conductor. . . . . In the arrangement adopted by Edison, the ratio between the energy consumed by the lamps and that wasted in the conductors remains the same as in the two-wire system, the two classes of resistance being increased four-fold each. The additional running expense due to heat waste in the conductors is not diminished in the least, while the cost of the conductors is diminished to three-eighths the former amount. If the principle is a good one that the most economical size of a conductor is attained when the loss by heating it equals the interest on its first cost, then clearly such a condition is not realized in the three-wire system, provided it is applied in determining the size of conductors in the old two-wire plan. The current being reduced 50 per cent., the size of the conductors should be reduced only the same fractional part. The E. M. F. required to maintain the current would then be less than 2E. In other words, the two dynamos could then be made smaller and could furnish a somewhat lower E. M. F. In the two-wire system the equation for the current gives $E = Cr + C R$, in which

E = difference of potential maintained by the generator between the two adjacent mains.
r = the joint resistance of all the lamps in multiple arc.
R = resistance of mains, and
C = current in mains.

If the size of the conductors were reduced only one-half, we should have

$$\frac{1}{2} C = \frac{2E}{4r + 2R}$$

Whence $E = Cr + \frac{1}{2} CR$ for the E. M. F. of each dynamo. So arranged, the three-wire system would secure a gain of 25 per cent. in cost of conductors, and a further gain in reduction of running expenses. This gain is readily estimated. The energy expended in the three-wire system with conductors reduced three-fourths in size is

$$\frac{1}{2} C \times 2E = C\ (Cr + CR) = C^2r + C^2R,$$

of which the first term is the energy spent upon the lamps, and the second denotes the waste upon the conductors. The energy expended with conductors reduced one-half in size is:

$$\frac{1}{2} C \times 2E = C\ (Cr + \frac{1}{2} CR) = C^2r + \frac{1}{2} C^2R.$$

From this it appears that the energy absorbed by the lamps is the same as before, while the energy wasted in

3. See also Prof. Cahart in *Science* iv. p. 477.

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the conductors is reduced to one-half its value in either of the other plans. The three-wire system, as arranged by Edison, permits of a saving of the interest on 62.5 per cent. of the cost of the copper conductor. A three-wire system with a reduction of one-half in the size of the conductors, allows a reduction of interest on 25 per cent. of the cost of conductors, and 50 per cent. of the running expenses due to heat waste, or a total of 75 per cent. of the interest on cost of conductors, a gain of 12.5 per cent. A further advantage to be derived from the reduction of the conductors to only half their original size, as compared with the reduction to one-fourth, is the lower temperature to which they will be exposed. With conductors reduced one-half in sectional area, the energy expended upon them, and therefore the heat developed, are only half the amount involved in either of the other arrangements; the thermal capacity of the wire being also half as great as in the two-wire system, the rise of temperature will be just the same. But if the conductors are reduced to one-fourth their original dimensions, while the quantity of heat generated in them remains the same, the rise of temperature will be four times as great as the two-wire plan.

We submit the question then, whether Mr. Edison has not sacrificed a portion of the advantage legitimately belonging to his device by attempting too great a saving in the cost of conductors."

In reply to the criticism of Professor Carhart, the author of the original article[4], while admitting the justice of his correction, suggests that Professor Carhart has not reached the most economical result "for the reason that we have the interest on n conductors, but heat developed in only 2 of them." He proceeds to develop the solution of the problem mathematically, by assuming the size of the conductors in the 2-wire system to be such that the interest on their cost equals the cost of the heat-energy developed in them, from which he deduces the following table of comparative results :—

EDISON'S SYSTEM.

No. of Conductors.	Cross Section of each.	Difference of potential at terminals of each dynamo.	Interest on conductors.	Heat-waste in conductors.	Running expense of conductors.
2	1.000	1.000 $CR + Cr$.	1.000	1.000	2.000
3	0.250	1.000 " "	0.375	1.000	1.250
4	0.111	1.000 " "	0.222	1.000	1.000
5	0.062	1.000 " "	0.156	1.000	0.875
6	0.040	1.000 " "	0.120	1.000	0.800

PROFESSOR CARHART'S PLAN.

No. of Conductors.	Cross Section of each.	Difference of potential at terminals of each dynamo.	Interest on conductors.	Heat-waste in conductors.	Running expense of conductors.
2	1.000	1.000 $CR + Cr$.	1.000	1.000	2.000
3	0.500	0.500 " "	0.750	0.500	1.250
4	0.333	0.333 " "	0.667	0.333	1.000
5	0.250	0.250 " "	0 625	0.250	0.875
6	0.200	0.200 " "	0.600	0.200	0.800

THE MOST ECONOMICAL PLAN.

No. of Conductors.	Cross Section of each.	Difference of potential at terminals of each dynamo.	Interest on conductors.	Heat-waste in conductors.	Running expense of conductors.
2	1.000	1.000 $CR + Cr$.	1.000	1.000	2.000
3	0.408	0.612 " "	0.612	0.612	1.225
4	0.236	0.471 " "	0.471	0.471	0.943
5	0.158	0.395 " "	0.395	0.395	0.791
6	0.115	0.346 " "	0.346	0.346	0.693

4. *Science*, v. p. 23.

In conclusion he says :—"Some very interesting comparisons of relative advantages might be noted, did space permit. The most important is the rapid increase in the ratio of heat energy to capacity of conductor in the Edison system, which might make it necessary to lay the wires so as to admit of pretty free radiation of heat.

"This question of temperature of electric-lighting conductors promises to protrude itself the more they are laid underground. The desideratum for an insulating covering would seem to be a non-conductor of electricity and good conductor of heat, apparently inconsistent qualities. Perhaps the eventual solution will be in bare or loosely covered wires on highly insulated points of support, thus admitting of free radiation of heat, like aerial lines."

THE ECONOMY OF ELECTRIC LOCOMOTION.

A WRITER in the *American Engineer* criticizes the estimate and calculations of Professor Farmer,[1] in reference to the cost of operating the elevated railroads in New York city by electricity. He says:—

Notwithstanding the high authority of Professor Farmer, we must express our conviction that these estimates are entirely too favorable. The total estimated saving is based on the higher efficiency of the large stationary engines and the cheaper coal used to generate steam. The weight of coal used by the stationary engine is estimated at 35 per cent. of the amount required by the 20 locomotives, at 1¾ and five pounds of coal per h. p. per hour respectively; and the coal of the central station is assumed to cost only ⅝ as much as the locomotive coal. The cost of coal for the central station would then be ⅝ of 35, or 22. per cent of present cost, a saving of 78 per cent. for the same power developed by the steam engines. This is undoubtedly too large; for while a steam engine developing 1 h. p. with 1¾ lbs. of best coal per hour are in use, yet so high an efficiency as that can hardly be expected of stationary engines in general, especially if they burn coal costing only $2.50 a ton. Further, the margin between this 78 per cent. and the percentages expressing savings in the fourth column of the table is very small. This margin must cover all losses whatsoever in transmission. It is to be noted, however, that the losses are to be estimated on the basis of loss of the cheap power of the large stationary engines and not of the comparatively dear power of the locomotives. Still it is difficult to see how Professor Farmer has reached such conclusions. He has perhaps wisely refrained from giving us any of his processes.

One difficulty with all these rose-colored estimates appears to be the entire failure to apprehend the difference between the intrinsic efficiency of a dynamo or a motor, and the efficiency of an arrangement consisting of a generator, connected by a conductor to a motor, for the purpose of transporting power. The intrinsic efficiency refers merely to the heat-waste in friction and internal induced currents. If the output of the generator is measured electrically and the E. M. F. measured is the difference of potential between the two binding posts leading to the machine, then the intrinsic efficiency would cover also the power consumed in maintaining the field magnets. We very much doubt if the dynamo has yet been constructed of such superior character that 10 per cent. of the mechanical power applied to it will cover loss in friction, fugitive currents, and maintenance of field magnets. We say nothing about armature resistance, though that will be very considerable in high E. M. F. machines.

But the efficiency of a combined generator and motor for transport of power depends not only on the efficiency of these machines *per se*, but also on the counter electromotive force furnished by the motor and on the resistance of the conductors. When power is transmitted from one machine to the other at the *maximum rate*, only 50 per cent. could

1. This Journal, vol. iv., p. 21.

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be recovered on the hypothesis that both machines are "perfect" electrical engines. If a higher return than this is desired then the motor must run under a lighter load, power must be transmitted more slowly, and the current must be correspondingly diminished.

The 20 locomotives on the Second avenue line are assumed to represent 2200 h. p. Other reports rate each engine at 40 h. p. But keeping to Professor Farmer's basis, this power in watts, or ampère-volts, is $2200 \times 746 = 1,641,200$. But as this is 90 per cent. of the power reaching the motors we have to supply 1,823,500 watts for absorption by them, or in round numbers, 1,800,000. If the twenty trains are supposed uniformly distributed over the 6.5 miles of track, and the generating station is placed at the middle, the average resistance of the middle rail is about 0.048 of an ohm, counting the resistance of the rail 0.05 ohm to the mile. The resistance of the return rail would be 620,024 ohm, making a total of 0.072 ohm in the rails. This is undoubtedly too small, because of the connections that have to be made from rail to rail. The resistance might be as low as this if the track and conductor were one continuous rail. Admitting that the resistance may be made as low as 0.072 ohm, and that the loss of 10 per cent. in dynamos and motors covers maintenance of field magnets and armature heat-waste, we can readily calculate the following table for a final recovery of 1,800,000 watts corresponding to 2171 h. p.

Current in ampères.	E. M. F. of generators.	E. M. F. of motors.	Effective E. M. F. difference.	H. P. lost in heat.	H. P. on circuit.	H. P. applied.	Per cent of expense saved.
5000	720	360	360	2412	4824	5360	45.9
4000	738	450	288	1544	3956	4395	55.6
3000	816	600	216	868	3280	3644	63.0
2000	1044	900	144	886	2798	3109	68.5

This table may be verified in the following manner: Energy in watts is the product of the current in ampères and the E. M. F. in volts. The product of the current and the E. M. F. of the motor, in each case, is 1,800,000 watts or 2412 h. p. nearly; and 90 per cent. of 2412 is 2171. The heat-waste may be estimated in the same way as the product of the current and the corresponding "effective E. M. F.", or as the product of the resistance and the square of the current. Thus

$$(4000 \times 288) \div 746 = 1544 \text{ h. p. or}$$

$$(4000^2 \times 0.072) \div 746 = 1544 \text{ h. p.}$$

We may find similarly the total h. p. equivalent of the electrical energy, or we may find it by adding the heat-waste in each case to 2412. Remembering that the electrical energy of the generator is only 90 per cent of the power applied, we obtain this latter readily for column seven. The final column is obtained by finding the ratio between the power applied and 2171 or the power recovered, multiplying 22 per cent. by this ratio and substracting the product from 100. If the coal cost more or the stationary engine is less efficient, the saving will of course be less for a double reason. With a current of 5000 ampères more power is wasted than is recovered—3189 h. p. lost to 2171 returned. The same is true with 4000 ampères. But still the total cost of this power, on the basis of the assumptions made, is only 54.1 per cent. in the one case, and 44.4 per cent in the other, of what must be expended by locomotives to produce 2171 h. p. per hour.

If the stationary engine consumes 2.5 pounds of coal per h. p. per hour, then the estimated savings will be reduced to 23.7, 37.4, 47.9, and 55.7 per cent. respectively. It is easy to see, therefore, that the estimated saving in coal is very precarious.

We may show also incidentally that limits are set to the E. M. F. that can be used when we determine the power to be absorbed by the motor and the resistance of the line. If E and E_1 are the E. M. F, of generator and motor respectively, taken as the difference of potential between the binding posts of each machine, R the resistance, and W the power absorbed by the motor, then we have

$$E_1 \, C = \frac{E_1 \, (E - E_1)}{R} = W = \text{a constant.}$$

If W and R are both constants then $E_1 \, (E - E_1)$ is also a constant. When the product of two numbers is given their sum is a minimum when they are equal to each other. The sum of E_1 and $E - E_1$ is E, the E. M. F. of the generator. In the case before us E_1 equals $E - E_1$ when each is 360 volts. Hence the minimum E. M. F. of the generator or difference of potential between its binding posts is 720 volts. Similarly an upper limit is established by the ratio of the counter to the direct E. M. F. In the present problem with a current of 2000 ampères, the counter E. M. F. is 86.2 per cent. of the direct. That is probably higher than is now attained in practice, and would correspond, in this case, to a direct E. M. F. of 1044 volts. The E. M. F. to be employed under the assumed conditions, would lie somewhere between 720 and 1000 volts, probably nearer the former than the latter. It is then easy to see on what doubtful grounds such estimates of savings as those of Professor Farmer are made. The percentages of savings in the last table are lower than his, but they are still undoubtedly too high, because of the assumed high efficiency of the stationary engines, the extremely low resistance of the electric circuit, and the minimum allowance made for losses in the dynamos themselves. When, however, we add to the possible saving in the full, the reduced expenses referable to other items, such as dispensing with skilled labor of locomotive engineers and the smaller loss from depreciation of rolling stock, it is evident that the faith of the foremost electricians in the entire feasibility of operating elevated roads by electricity is well founded.

ELECTRIC LIGHTING IN AMERICA.

The following is an abstract of a paper with the above title, read before the Society of Arts, London, by W. H. Preece, F. R. S., after his return from an extended trip in this country:

Electric lighting flourishes in America much more than in England. There are probably 90,000 arc lamps alight every night in the states, and there are many central stations working regularly, both with arc and with incandescent lamps. Contrasting the brilliantly illuminated avenues of New York with the dull and dark streets of London, Mr. Preece states that on the evening of October 21 he drove from the Windsor Hotel, New York, to the Cunard wharf, a distance of about 4 miles, through streets entirely lighted by electricity. On October 30 he drove from Euston to Waterloo without seeing a single electric light.

Mr. Preece visited Montreal, Philadelphia, Buffalo, Cleveland, Chicago, St. Louis, Indianapolis, Boston and New York, and found in each city the principal streets and warehouses, as well as stores and places of public resort, lighted by arc lamps. With arc lighting the greatest advances have been made in the states. One manufacturer turns out as many as 800,000 carbons for arc lamps per month; another says that his output of plant is 50 arc lamps and 3 dynamos per day; and while present at a third factory, Mr. Preece mentions an order was received for an electric lighting plant of 330 arc lamps, requiring 14 24-light dynamo machines, intended for an installation to light up a park in the environs of Chicago. In that city the number of arc lamps installed has doubled, increasing from 1,000 to 2,000 during the past 12 months. More than one electric light company pays dividends to its shareholders, and all the manufacturers, as well as the lighting companies, seem to be full of work.

The principal systems in use are, for arc lamps, the

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Brush, the Weston, and the Thomson-Houston; but there are other arc systems, not so well known on this side of the Atlantic, such as the Hochhausen, the Van de Poele, the Western Electric, the Fuller, the Sperry, etc.; for glow lamps, the Edison and the Weston. Visiting central stations in various towns, Mr. Preece found 164 Thomson-Houston arc lamps alight in the public streets and shops in Montreal. The rate of payment was 50c. per lamp per night from dark to midnight, or over £35 per lamp per annum. At Philadelphia the Brush system, employing 1,200 h. p., supplies electricity for nearly 1,000 lamps, for which £60 per lamp per annum is charged. The Brush people have also two central stations at Boston, lighting up 816 arc lamps; in fact, there are few towns of any consequence in the states that do not possess central stations worked by the Brush company, and probably there are 25,000 Brush arc lamps in use in the United States.

At Chicago all the drives in the Lincoln Park are lighted by arc lamps with very good effect, especially on the unique drive skirting the shore of Lake Michigan. Other companies also have central stations in Chicago. The lecturer did not see in the states one single instance of street lighting by glow lamps. In every case arc lamps were used for this purpose, and they were usually fixed on much taller posts than in England. Although brilliant, the effect was by no means perfect, and no effort seemed to be made to distribute the light uniformly, as had been done in England by Mr. Trotter. The price paid in New York is 70c. per night, or £50 per annum, for each arc lamp; but a fine of about 6s. for each time any lamp is reported out is inflicted.

As regards incandescent lighting, it does not seem to flourish so much as arc lighting, nor, indeed, has it been applied to private houses to the same extent as in England. The principal system of incandescence in practical use is that of Edison. House lighting has been attacked principally by the Edison company. They have a central station in New York, which was opened on September 3, 1882, and from that date to the time of Mr. Preece's visit there had been only two hours and a half stoppage, and that due solely to carelessness. There are 587 subscribers, using altogether 12,764 lamps, served day and night. The price charged is the same as that which would be paid if gas were supplied at 7s. 6d. per 1,000 cubic feet, whilst the price of gas has now been reduced to 5s. 9d. The use of secondary batteries has not received so much attention as on this side of the water.

No difficulty is found in determining by the Edison meters the charge to be made, the subscribers paying for the light they receive, and not for the current they use. These bottle measurements are unquestionably accurate within 1 per cent.

Mr. Preece sums up the results of his investigations in the following statement of the general commercial position :

The problem as to whether electric lighting is practical, and as to whether that means of illumination can be made to pay, has been thoroughly solved in the United States. The great mistake that has been made there, as it has been made here, has been the attempt to enter into competition with gas. The Edison company started on the basis of the charges made for gas, and the result of the two years' working has been to show that this was a financial mistake. Electricity must earn its future success entirely upon its merits, and not on its economy. In the case of street lighting it has proved itself to be a good thing, and if once a thing is proved to be good in America, it is immediately taken up. "Progress," in that country, is the word. Novelty is a certain criterion for consideration. Manufacturers do not hesitate to clear out their entire factory, if they find that they can get cheaper and better work by entire renewal. So with the electric light. If it proves itself (as it unquestionably does) to be a better light than gas, then gas fittings will be instantly removed, and electric light fittings substituted, without particular reference to the cost, so long as it is reasonable and within the means of the consumer.

I have said, more than once, that at the present day we can only regard the electric light in England as a luxury, and we must pay for it as a luxury. But there is no reason why it should always remain a luxury. There are various chances of economy which justify the conclusion that, sooner or later, the price will be brought down so as to relieve us of the use of the term luxury as applied to it. For instance, the output of the dynamo can be extended, as has already been done with several types, particularly, as I have pointed out, in the case of the Brush pattern, where 60 arc lamps are now lighted where only 40 lamps were supplied by the earlier and unimproved machine.

Again, considerable reduction in the weight, and therefore in the cost, of the conductors has been obtained by the production of the 3-wire system. Moreover, when existing patent rights lapse, the manufacture of dynamos will become general, and the consequent competition will, no doubt, result in the production of efficient machines at a sum far below the cost of those made under existing patent rights.

The efficiency of the glow lamps has also been very considerably affected by the improvements made, for instance, by Messrs. Woodhouse and Rawson, and by Mr. Bernstein. The efficiency of the Edison lamps means the consumption of energy at the rate of 5 watts per candle, but lamps are now being made which give an efficiency of 2.5 watts per candle, with an equal life, which is equivalent to an immediate reduction of 50 per cent. in the amount of energy required to maintain the system alight, and, therefore, in the cost of its production.

There is still vast room for economy, and it is quite clear that the prices which are now necessary to make electric lighting pay, must not be regarded as final; they will be brought down.

Even now it is possible, in England, to make a system pay at the rate of a halfpenny per glow lamp per hour; and no one who has ever experienced the charm and comfort of the electric light, and who has electricity brought to his door, and supplied to him at this rate, would hesitate to pay that figure for the use of electric lamps, although he could obtain the same light by gas at less than half the price.

There is a point that will lead to the introduction of the electric light that is very marked in the United States, viz., its influence, when applied to the streets, upon the morality and safety of the public.

The chief of the police of New York has gone so far as to say that "every electric light erected means a policeman removed." This, though probably not true as regards actual numbers, is so far true in fact, that the supervision of the streets and thoroughfares is rendered far simpler when they are brilliantly illuminated by the electric light. Its moral effect is principally to be noticed by the way in which it has checked the formation of crowds, and disturbed the haunts of those who, unfortunately, infest most great towns and cities, and who render the streets of London at night a disgrace to modern civilization.

An interesting discussion of Mr. Preece's paper was then participated in by other members present.

Mr. Hammond said it was not his privilege to go to America with the British Association, but he was there last year, and did not keep so much to the east as Mr. Preece had done. After leaving Chicago, he again found the electric light at Denver, in Colorado, in Salt Lake City, and in San Francisco, where he found, perhaps, the finest hotel in the world lighted throughout by electricity. The Americans, therefore, had gone much farther ahead than we had, but it was very desirable to draw the correct lessons from what was to be seen there. They were sometimes told that the English were very slow, but it was not entirely due to want of enterprise that in this matter we were behind the states. One great point was the price of

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gas, which was much dearer in America than in England. Again, many of these contracts in America, though they might not involve any loss, did not show any profit. In order to get sole control of a town, the municipality had in some way to be accommodated, and this was done by supplying them with the electric light at 50 cents per night; but it would not pay even here to supply an arc light of 2,000 candles at £35 per annum; at any rate, if you did not lose, you would make nothing by it. There were many cases where the price was double and treble, and where good profits were being made, but it was in localities like Salt Lake City, where people had plenty of money to spend, and where gas was about 17s. a thousand, that the best place for the electrical engineer was to be found. In some places in the west they had no light at all, and would have given anything for the electric light. Again, the Americans were very enterprising in business; they worshipped the almighty dollar, and looked upon the electric light as a good advertisement. A man would, for the sake of outshining his rival, put the most flickering arc light outside his door, and his experience was that the American arc lights were far behind our own. Again, the heat there was very great, and whilst in England some people liked the warmth of gas, in America no one would go to a hotel not lighted by electricity, if there were one opposite which was. It was, however, used simply for business, and was an advertisement. The man who would have it in his store would not think of using it at home to make it more comfortable, because it cost too much. Gradually, however, some of the leading Americans were introducing it for domestic purposes; but when he was in New York, Mr. Edison had not got it in his new house, and Mr. Brush had not got it in his in Cleveland. It was remarkable to see the effect the overhead wires had had on Professor Forbes. An Englishman in New York would think London a peaceful village in comparison. There was a railway overhead, the passengers on which could converse with the people at the first floor windows along the route, and there were these posts with 60 and 70 wires on them all along the principal streets; in 5th avenue they were worse than anywhere. He did not mind them himself, but they must not regard this matter simply from the point of view of those who lived by electric lighting, and he was sure such things would not be tolerated in England. There was no Board of Trade in America, but he was sure they would find it better eventually to put the wires underground, when the system was firmly established. But directly they wanted to put them underground in England, they had to apply to Parliament for permission; in America it was only necessary to find out the man who represented the municipality, and the matter was easily arranged over a long drink at the bar. That was local option; but in England they had to go to Parliament. As they urged on Mr. Chamberlain, the other day, why should not the local authorities be empowered to grant liberty to any company, in whom they had confidence, to put wires underground? It was a mere accident of their industry that they had to deliver electricity by wires; if they could deliver it like other wares, by van, they would not need to ask Parliament anything about it; but because they had to use wires, a delay of some 18 months, and all kinds of difficulties, stood in their way. The great lesson to be learned from America was that it could be done. There were hundreds and thousands of people ready to pay double the price of gas for the electric light, but capitalists were constantly saying they were told it could not be done. Mr. Edison had shown in New York that incandescent lighting could be supplied from a central station, and that when done on a large scale, the risk of failure was infinitesimal. In New York they were able to make a small margin of 3 per cent., using 5 watts per candle, getting 7s. 9d. for it, and paying $\frac{4}{5}$ths for the manufacture. In England it could be produced with 3 watts per candle, at a cost for manufacture of 3s. 8d., instead of 6s. All the installations in America had been made in one way, taking the current direct into the houses. A reference had been made to storage batteries, but in no case had they yet been used as a part of a general system, as we hoped would soon be introduced in London, and with a much less capital outlay. If in New York they could make 3 per cent. on a capital of £200,000, which included an immense amount sunk in experiments, they might hope, in England, to make 8 per cent. on a capital of £70,000, which would be sufficient, with proper plant, and the advantage of further experience; and by working at 3-5ths the cost, they might even hope to make 12 per cent.

ELECTRIC LIGHTING FOR RAILWAY COACHES.

Considerable attention has been devoted in England to the lighting of railway trains by electricity, but there are many obstacles to overcome, and it is doubtful whether any of the various plans devised can yet be considered thoroughly successful. The London *Electrical Review* publishes the following comments upon the different systems which have been proposed or tested :—

"In the *Electrical Review* for January 12th of last year we commented at some length upon two systems which had been brought forward for providing our railway carriages with an effective light by the application of electricity. One method was that of employing a dynamo and driving engine combined and carried by the locomotive, the boiler of the latter supplying steam; the other consisted of a combination of dynamo and accumulators, the generator of the electric current being driven by means of belting from the axle of part of the rolling stock.

"We stated at the time that anything electrical in connection with railway operations should be of the most simple nature, and that we should therefore be inclined to place most confidence in that system which apparently offered the least chance of failure. It is therefore not a little gratifying to find our views generally supported by such well-known men as Messrs. W. H. Massey, Gisbert Kapp and R. E. Crompton, although we must, in justice to the advocates of the accumulator system, admit that Messrs. Stroudley and Houghton have been most successful in the application of the dynamo-accumulator combination. In the method first mentioned the objection that the lights are extinguished whenever it may be necessary to uncouple the locomotive engine which carries the dynamo was naturally raised. Mr. Massey meets this by remarking that such a contingency ought not to weigh with those who know from experience that it makes little or no difference in well-lighted stations whether the carriage lamps are lighted or not. This argument is ingenious, but fails from the fact that we do not yet possess the well-lighted stations which would diffuse sufficient illumination through any carriages there standing. Mr. Kapp goes further and makes a practical suggestion for meeting the difficulty. This gentleman, in the correspondence columns of a contemporary, says there is no reason whatever why the lights should be extinguished for a single instant, although the train might be left standing without its locomotive for any length of time. All that would be required would be a dynamo fixed in the station where the trains are made up and the provision at suitable places along the platforms of flexible twin cables in connection with the main leads from the dynamo. Some of the coaches in each train, or preferably all the coaches, should be provided with terminals connected to the main leads throughout the train, which would fit a clip attached to the end of each pair of flexibles. To prevent reversal of polarity the clip should be so arranged that it would only go on one way, and the flexibles might be stowed away under the edge of the platform in the same way as are the India-rubber gas pipes in Broad street and other stations.

"Immediately a train comes in the nearest flexible would be clipped on to any of the terminals within reach, and for

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the time being the train would be lighted jointly from the dynamo on the locomotive and from that fixed in the station. After detaching the locomotive, the station dynamo would continue to light the train until a new locomotive was coupled on. The dynamo in the station, with its engine, leads, flexibles and clips, would be far cheaper, thinks Mr. Kapp, than a set of accumulators for every train, and would also have the additional advantage of serving at the same time for the permanent lighting of the station. Mr. Crompton adds:—'I would call attention to the self-evident fact that electric lighting mechanism does not differ from other mechanism, in that trustworthiness and efficiency go hand in hand with simplicity and few parts. Again, although no prominent mention has hitherto been made of the fact, there is absolutely no comparison between the cost of direct running and of the van dynamo-accumulator system, the cost of the latter, whether for first cost or for maintenance, being quite double that of the former.'

"It appears, then, that the three gentlemen whose opinions we have quoted are all in favor of electric lighting being carried out without the addition of secondary batteries to the plant. The suggestion of Mr. Kapp is a novel one, but there are, we think, grave difficulties in the way of practically carrying out the scheme.

"We imagine that in many instances there are stations in which trains are made up, or, at all events, where carriages are taken on and off, so unimportant in themselves as not to warrant the adoption of a dynamo and engine for permanently lighting the usual offices and platforms. There would again be considerable difficulty in preventing short circuiting or leakage from a set of flexible leads when used and stowed away in the manner of India-rubber gas pipes, and the probabilities are that the station itself would frequently be left in darkness from such causes. Nevertheless Mr. Kapp's idea is one which, for special cases, we are inclined to think worthy of a trial. The great advantage possessed by the present modes of lighting railway carriages is, especially so far as oil lamps are concerned, that each carriage is independent of its neighbors. In cases of a breakdown, or of more serious disasters, this is a desideratum, the importance of which can scarcely be over estimated. Whether this will ever be accomplished by means of electric lighting remains to be seen; if so, it certainly will not be by the method of supply upon which we have just commented. Secondary batteries are being improved, and their weight, for producing a given effect, much reduced, and we can yet conceive each carriage supplied with three or four cells to work a low resistance incandescent lamp so as to render each car independent of the rest. Such a scheme would, of course, necessitate the provision of charging stations, but if tram cars are to be propelled and lighted by the means pointed out by us a fortnight ago, and Mr. Reckenzaun's recent experiments appear to point to such a happy result, what is to prevent the latter application, eventually, to railway trains?

"Improvements in nearly all branches of the applications of electricity have been so rapid and important that it is rather venturesome in the present day to give decided opinions on any matter which is not already well established. We will, therefore, only add that we trust the new year will provide abundant opportunities for the fair and impartial trials of every system which promises good and lasting results."

ELECTRICITY FOR STREET RAILWAYS.

Among the special committees appointed at a convention of the American Street Railway Association, was one which was to report on "Electricity as a Motor for Railroad Transportation." The facts elicited, although not wholly new to our readers, show that attention is being generally directed to the subject. The report as given herewith is from the *American Railroad Journal:*

The Committee on Electricity as a Motor for Railroad Transportation is not prepared to make a report from personal inspection; but from the information received from different sources, they feel justified in reporting the possibilities of the new system to be very flattering. The experiments made in different places demonstrate beyond question its safety and practicability; and it will not be long before the question of economy will be fully determined by the experiments at Cleveland. In this country and in Europe, there are now several electric railroads in successful operation. The Litchterfelde road, in Berlin, has been for 4 years a financial success, and the results of the experiments at Coney Island, Menlo Park, and by Messrs. Daft and Edison, at the Mechanics' Fair building at Boston, Mass., have thus far been very satisfactory and encouraging. I herewith submit for your consideration the enclosed communication of Mr. W. H. Knight, of the Brush Electric Company, of Cleveland, Ohio, giving the result of the Cleveland experiment in detail. This letter, coming as it does, direct from the operator of the street railroad at Cleveland, in response to a request from this committee soliciting such information as would be valuable and interesting to the convention, is really the sum and substance of this report, and contains all the reliable information before this committee.

As chairman of the committee I confess that I have not given to the investigation of this question as much of my attention as its importance demanded; but the unusual pressure of official duties during the last 6 months has occupied all my time.

Ed. C. Peters, *Chairman.*

Brush Electric Company, Cleveland, O.,
October 8, 1884.

E. C. Peters, Esq., *Chairman Committee on Electricity as a Motive Power of the American Street Railway Association.*

Dear Sir,—Your favor of the 30th ult. is at hand, and contents noted.

The electric railway which we are now operating here is about one mile in length, and at present only one car is run on it. The second car will soon be completed, and the line will then be extended across the railway tracks to a distance of about one and a-half miles. This section, with its 2 cars will be operated all winter without intermission, to demonstrate the "rough and ready" character of the motor, after which the system will be extended over the 20 miles of tramway owned by the East Cleveland company. Last winter we operated a trial railway, built in the yard of these works; and as it stood the tests of all kinds of weather, we have no doubt in our own minds as to its efficiency the year round. Briefly the system may be described as follows:

Midway between the rails a conduit 8 inches deep is laid flush with the pavement, in the manner of a cable road. Two iron rails serving as conductors are supported within this conduit, and through a slot five-eighths of an inch wide in the top of the conduit, a plow depends from the car, and by means of 2 brushes makes contact with the conductors. Through this plow the current is conveyed to the motor, which is situated between the wheels under the car, and is tightly boxed up to prevent access of dust, etc. The motor weighs half a ton, and the car is an ordinary 2-horse box car, weighing, exclusive of motor, 2 tons. The motor is geared to the axles of the car by friction gear and link-belts. The movement is controlled by levers at either end of the car, these levers operating the commutator brushes on the motor to start, stop, or reverse the motor, or to make it go at any speed desired. It has been run at a speed of 15 miles an hour.

The dynamo supplying the current is located about a mile from the line, and is run by the engine used by the company for grinding corn. It is connected to the conduit by an over-head line of No. 8 wire. In practice, no over-head line will be used, and a greater economy may be anticipated. The power is sufficient to run 2 cars, as the engine and dynamo after being started in the morning, runs all day without attention. Only one man is employed to do the firing, and the expense of power, including fireman, coal and oil is about 4 dollars per day. With a larger plant, larger and more economical engines, boilers and dynamos would be used, and a much greater economy obtained.

The conduit will cost from five to seven thousand dollars a mile when made of steel, and it ought to last a lifetime. To equip an ordinary 2-horse car will cost in the neighborhood of $1,500, and the power at the central station for each such car will be in the neighborhood of $1,200. Each car will pull another car of the same size. The steepest grade we have experimented with is 500 feet to the mile, and no difficulty was found in overcoming it. The conduit is kept free from dirt, snow, etc., by a brush depending from the car through the slot. Catch-basins are placed at intervals varying from 50 to 100 feet, and where possible a sewer connection is made. The system is similar to a cable road in that it requires a conduit and a central power station; but it differs in every other respect.

It may be operated on single tracks as well as on double tracks; and branches may run out from the main road in every conceivable manner. Any speed may be assumed at the will of the operator without wear of machinery. Ordinary car-drivers

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can operate it after five minutes' instruction. Stoppages can be made quickly by reversing the motor. Running off the track does not injure the machinery, and a flexible connection on every car enables the motor to run the car back on to the track when the lever is reversed. A much smaller conduit can be used than with cables, and there is no machinery along the line. The conductors cost but $200 a mile, and the wear of the brushes upon them seems to be *nil*.

We use a high tension current because our investigations have showed us that when distances greater than 1 or 2 miles are to be overcome, no other current will give the necessary economy. The conductors are, however, inaccessible, and no danger is anticipated. We are ready to equip any road not exceeding 25 miles in length.

Hoping I have touched upon the main points of interest,

I am, very truly yours,
W. H. KNIGHT.

LITERATURE.

REVIEWS.

Illustrations and Descriptions of Telegraphic Apparatus. By ASTLEY C. TERRY and WILLIAM FINN. Buffalo: A. C. Terry, 1884.

THE plan of this work is essentially different from that of most others of the kind. It consists principally of a series of theoretical diagrams embracing all the different systems of apparatus now used in American telegraphy, which are consecutively arranged in the volume and accompanied with the necessary explanatory text. There are in all some 30 full-page plates, and these are not only skillfully and artistically designed, but have been executed with the highest skill of the engraver's art. As we have intimated, the plan adopted by the authors is not that of a consecutive treatise, but rather that of a book of reference, and it is apparently designed more particularly for the use of wire-chiefs, office managers and the higher grade of telegraphic operators who are supposed to be already conversant with the ordinary apparatus which of late years has come to be known distinctively as the "plain Morse." Among the minor subjects illustrated and explained are switch-boards, special arrangements for small stations for working either a sounder and register from one relay, a sounder on either one of two relays and the like. The different forms of repeaters in practical use are all given, among others Neilson's shunt repeater, an invention largely used in Canada of which we do not remember to have seen a description elsewhere. The duplex and quadruplex apparatuses with the various modifications necessary to adapt them to use under different conditions of service, are given with much completeness and attention to detail. The Wheatstone automatic duplex system with its special form of repeater is very carefully described and illustrated, and also the universal Gold and Stock printing telegraph system and Gray's multiplex harmonic apparatus. A chapter on line testing and measurement both with the tangent galvanometer and Wheatstone bridge is given, which is profusely illustrated and accompanied with explicit and carefully prepared instructions.

The excellencies of this work are numerous and its faults are few. The descriptive text is concise, and well prepared, and we notice no errors or omissions of particular importance. The polar duplex with battery at one station only, should have been credited to Edison, it having been invented by him in 1872 or 3, and having in fact constituted his original conception of the method of simultaneous transmission by changes of polarity and changes of strength in the current, upon which the quadruplex was afterwards founded.

It is impossible to speak in too high praise of the mechanical execution of the work. We have already mentioned the excellence of the illustrations, and it is only necessary to add that the typography, printing and paper are of equally high quality and reflect the utmost credit upon the taste and skill of the printers and engravers, Messrs. Matthews, Northrup & Co., of Buffalo. We observe however one fault in the make-up of the volume which might have been avoided by a little ingenuity, namely, that the text referring to a particular illustration often appears on the page facing some other illustration, which is not only an exceedingly inconvenient arrangement but is in some cases liable to cause confusion. The insertion of a few additional pages would have remedied the difficulty and the surplus space might with advantage been utilized for tables or other information frequently required in making tests.

Every telegraph operator who is ambitious to excel in his business, will find this work of very great assistance to him, while as a work of reference, it will be found indispensable in every telegraph office.

The Fireman's Guide; a Hand-Book on the Care of Boilers. By KARL P. DAHLSTROM, M. E. New York: E. & F. N. Spon, 1885.

This work was originally prepared and published by an engineering society of Stockholm, Sweden, it having been thought that the most certain way to insure economy of fuel among steam-users, as well as to prevent accident, would be to furnish detailed regulations and explanations to the men entrusted with the firing and management of steam boilers. The original work appears to have been favorably received, as it passed through a number of editions. The present volume is mainly a translation of the Swedish work, but has undergone some change and revision at the hands of Mr. Dahlstrom.

The book is quite brief—only 26 pages in all—but is very much to the point. It is divided into two parts, the first containing explicit directions for the general care of boilers and the second a short summary of rules for the guidance of the fireman. The first chapter carefully explains the proper manner of firing, by which the greatest efficiency is attained with the least expenditure of fuel, a matter which requires much experience, intelligence and judgment, contrary to the opinion of many owners of boilers, who think that the cheapest man they can hire is necessarily the most economical, forgetting that he may easily waste enough fuel and do enough injury to the boiler to amount to many times the sum total of his wages. Another chapter is devoted to the maintenance of a proper supply of water in the boiler, in connection with which, the management, of the feed-pumps, injectors, gauges and other appliances is set forth in detail. The process of emptying, cleaning and refilling the boiler is given, with great particularity.

The whole work is couched in the plainest possible language; is eminently practical, and within the comprehension of any workman of the most ordinary intelligence. We should be glad to see it in the hands of every fireman, engineer and boiler-owner in the country. It is scarcely possible that any such person could fail to find within it some piece of information of far more value than the trifling cost of the work. The book is clearly printed in a convenient and portable form on good paper, and is substantially bound.

RECENT PUBLICATIONS.

Dahlstrom, K. P. The Fireman's Guide, a handbook on the care of boilers. New York: *Spon*, 1885. 26 p. 12°. 50c.

Delahaye, P. L'Année Electrique, an exposè annuel des travaux scientifiques des inventions, etc. (Premiere Année.) Paris: *Baudry*, 1885. 312 p. 12°.

Fontaine, H. (See Niaudet, A.).

Hiltebrand, E. Subject catalogue of the memorial library of the International Electrical Exhibition, held under the auspices of the Franklin Institute. Philadelphia: *Franklin Institute*, 1884. 165 p. 8°.

Niaudet, A. Fraile élémentaire de la pile électrique, 3me ed., revue par H. Fontaine. Paris: *Baudry*, 1885. 352 p. 8° (illustr.).

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents. Anonymous communications cannot be noticed.

The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.

In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.

Sketches and drawings for illustrations should be on separate pieces of paper.

All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

ELECTRIC LAMP HANGER.

[31]—Instead of the adverse opinion given in answer to inquiry of "T. D. R." referring to "raising and lowering of arc lamps," page 24, vol. 4, would not impartial justice rather have referred him to parties who, claiming an exact acquaintance with every form and feature of the device referred to, could speak advisedly?

But we beg to take back this suggestion if "T. D. R." was simply the victim of a typographical error.

T. & J. W. WARD.

Room 2, Montauk Block,
Chicago, Jan. 28.

CORRECTION IN PATENT STATISTICS FOR 1884.

[32]—Please insert the following correction.—In my statistics of electrical patents on page 45 of your February issue, a trifling error has been printed. The following is the correct reading:

Conductors:

Cables—Compound Conductors and manufacture of the same	41
Insulated Wires, etc.	17
Insulating Materials	8
Line-wire—Compound Wire, etc.	13
Underground Systems	51

The record may as well be correct.

THOS. D. LOCKWOOD.

Boston, February, 5, 1885.

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QUESTIONS AND ANSWERS.

[58.] **Works on Atmospheric Electricity.**—G. E. C., Stoneham, Mass., asks:—What is the best book on Atmospheric Electricity? **Ans.**—We know of no special treatise on the subject of any great value. Noad's *Manual of Electricity*, a large and rather expensive work, contains, perhaps the best exposition of the subject. An excellent paper, by David Brooks, may doubtless be obtained of the author, 2,008 Chestnut street, Philadelphia. If you wish to pursue the subject it might be well for you to subscribe to the *American Meteorological Journal*, $3 per annum, W. H. Burr & Co., Detroit, Mich.

[59.] **Electrical Indicator—Dynamic Units.**—G. N. V., Linden, N. J., inquires:—1. Would a good system of transmitting the variable indications of thermometers, barometers, height of water, etc., automatically, over a single wire, keeping both transmitter and receiver in perfect unison, with an open circuit battery, be a paying invention? 2. In thermo-dynamics, what is an unit of heat, and an unit of work, and what relation do they bear to each other? **Ans.**—1. We cannot undertake to predict whether any given invention will "pay." As a rule the pecuniary results depend far more upon the business management, than upon the merit of the invention. Such a system is now being introduced in this country. See page 265, vol. iii., of this journal (December, 1884). 2. The unit of heat is usually defined as the quantity of heat required to raise the temperature of one gramme of pure water, at 0° centigrade or 32 Fahrenheit, through one degree centigrade. It is called the gramme-*degree*. The unit of work is called the *erg*. It is the amount of work done by one degree working through the distance of one centimetre, the degree being the force which, acting upon one gramme for one second, generates a velocity of one centimetre per second. One gramme-degree is equal to 42,000,000 ergs. By Joule's original determination, 772 foot-pounds of work is equivalent to the quantity of heat required to raise one lb. of water through 1° Fahrenheit.

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Complicated Competition Among Quotation Companies.—The Gold and Stock Telegraph Co. Moves its Headquarters.—Tottering Telegraph Companies.—A Brilliant Resolution.—Long Distance Telephony.—Electric Lighting for the Post-office.

It is doubtful if there has ever been a period of such fierce competition in various branches of electrical service as at the present time. The business of lighting the streets appears to be amicably divided between the local United States, and Brush companies. In isolated plants, however, there is considerable rivalry both in arc and incandescent lighting. Those who engage service of this kind should make their bargain with care, as we learn of one instance where a patron desired to dispense with the old, and substitute the new, but the original occupant refuses to budge, and the other company will not run its wires, until the old ones are out of the way, while the owner does not dare risk the lives of his subordinates in the hazardous employment of removing dead wires.

The field so long and successfully cultivated by the Gold and Stock Telegraph Co., is being vigorously stirred up by its rival, the Commercial Telegram Co., whose managers have been stimulated to renewed exertions, by the decision in its favor, referred to in these columns last month. The Baltimore & Ohio company is also preparing to engage in a similar service, and if it follows up the quotation business with a war of rates, none of the contesting parties will enjoy the comfortable revenue earned for so many years past. The Stock Quotation Co., under the supervision of Mr. W. F. Coffee, is actively engaged in construction, and notwithstanding the state law, the wires are being placed overhead, but on housetops instead of poles. Superintendent George B. Scott, and Assistant Superintendent Charles S. H. Small have removed from the offices occupied by them in the Western Union building, to the new offices at No. 16 Broad street, which is in the heart of the stock brokers territory. The operating department of the company will soon follow, and battery power will be dispensed with, as arrangements are now being perfected to depend entirely upon dynamos to drive the hundreds of type-printing instruments. It is only about eight years since this extensive operating plant was moved from 61 Broadway to the then new Western Union building, which at the time was very generally considered an unwise change. The entire expense of the two removals, will probably exceed $200,000.

The competition of these different quotation companies is further complicated by the prospect of a war between the different exchanges, all of which depend more or less upon the telegraph companies for their quotations, The contract by which the Gold & Stock company held its privileges upon the floor of the Stock Exchange expired some time ago, and for the monopoly of such a right it agreed to enter vigorously upon a war of extermination against the bucket-shops. This matter has been discussed by the Governing Committee of the exchange but no decision ever reached. It is now reported that the company has made overtures to the Mining Exchange, the consummation of which would necessitate its entire withdrawal from the Stock Exchange. In this case the latter would probably depend on the Commercial Telegram Co., as it would scarcely be possible for it to organize a perfect system of its own in less than six months. As the Calahan patents upon which the Gold & Stock company has based its claims for many years expire very soon, it will readily be seen that there is every probability of quite a disturbance in the financial district of the metropolis.

The tribulations of the Bankers and Merchants' company under the receivership create considerable gossip. The six months default of the interest due on the bonds of the American Rapid company has about expired when the owners of the latter will make a move to regain possession of their property. Meanwhile there are rumors of various deals, both with the Western Union and Postal companies. A report has also been circulated that the latter company was to be wiped out of existence on account of its inability to meet its obligations. All reports of this character are vigorously denied by interested parties, yet dissolution or consolidation in some cases, can only be a question of a year at most.

The following is one of a series of resolutions, offered by Mr. O'Donnell at a meeting of the Railroad Commissioners at Albany on the 13th inst., which were adopted by that body.

Resolved, That a communication be sent to the elevated railways of New York city inquiring as to the utility and practicability of providing a system of lighting the entire length of the tracks of their respective roads with electric lights, to be used in case of foggy weather, with a request for an answer within 10 days.

It would be interesting to know what this gentleman desires to accomplish.

The long-distance telephone enthusiasts continue their periodical tests with Chicago over the wires of the Postal company. The immense satisfaction derived from the conversation is reported as follows in a New York daily, whose reporters are apparently never omitted when the invitation lists are made out. Mr. Eastman of New York and Mr. Armour of Chicago were the participants:—

"Is it true that Chicago girls have big feet?"

"You mustn't ask me such questions," called back Mr. Armour. "Ask me something easier."

Mr. Eastman put his lips to the instrument again and asked in a lower voice: "What is the price of May pork?"

"May who?" inquired Mr. Armour from Chicago.

"May wheat," yelled Mr. Eastman, changing his question.

"I don't know who you mean," replied Mr. Armour, apparently a little confused.

"What was the run of cattle to-day in Chicago?"

"Five thousand," came the answer.

"Correct," said Mr. Eastman. "Can't you tell me now what May wheat closed at?"

"Eighty-four five-eighths," came Mr. Armour's answer, and Mr. Eastman repeated it to the waiting guests in the Postal company's New York office.

Among the original locations of the arc lamps in this city were the Post-office and the Grand Central depot. Both of these buildings are now lighted with gas. The complaints of impure air, and defective illumination in the Post-office have however led to a further investigation of the merits of electricity, and United States Marshal Erhardt has for some time been in favor of substituting it for gas. It is now proposed, however, to make more general use of the incandescent lamp, which if properly introduced will probably remain.

New York, February 25, 1885.

CHICAGO.

An Important Call-box Patent.—A Novel Telephone Exchange Enterprise.—The Central Union Company's Lines.—A New Storage Battery.—Underground Progress.—The Dorsett Conduit System.—How a Gas Engine was Tamed.

All who are familiar with the mechanism of telephone call-boxes are aware of the many devices for shunting the circuit, invented by the various manufacturers. From the original, which required the manipulation of a push button, there have been constant changes to produce automatically the same result by the turning of the magneto crank. In one of these the crank is insensibly thrust inward to shunt the circuit, another produced the same change by centrifugal force, a third accomplished the same result by means of lost motion on the attachment to the crank shaft, and so on. Each of these, to a greater or less extent, has been adopted by telephone companies, and several of the various systems have been in interference in the patent office. The outcome of all this contest has been reached, and December 23d a patent was granted to Elisha Gray, two of whose claims are as follows:

The combination with a magneto or dynamo-electric machine, of a main

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circuit and a shunt or short circuit around said machine, and means for automatically breaking such short circuit upon and continuously during the operation of said machine.

The combination of a driving shaft of magneto or dynamo-electric machine and a sleeve mounted thereon, in such manner as to have a longitudinal movement thereon, and a circuit breaker automatically operated by the longitudinal movement.

As a very polite captain of home guards used to say, during the late war, so may it be remarked to some venders and users on this solemn occasion: "About face, gentlemen, if you please."

A party who shall be nameless, lately conceived the idea of an independent telephone exchange here, and obtained a public telephone, which was placed in his office. It hardly seemed to the telephone people that he was justified in doing this, considering his business location and other circumstances. In the course of a few days, however, it was discovered that he was doing a rushing business with his public telephone, and investigation showed that he had opened an independent exchange, switchboard and all, and was giving city connections to parties using "bogus" instruments on about 15 surreptitiously placed lines leading to his office. His wires, and his revenue as well, were suddenly cut off one fine day, and the flourishing little exchange has been closed.

The Central Union company claims to have about 10,000 miles of toll line wires scattered throughout their territory. They have 140 complete exchanges, and a lot of "kitten" exchanges, with from two to ten subscribers each, about 100 in number. Between Lasalle and Peru, in this state, where they have several wires, there is a lot of zinc furnaces which the lines pass in the immediate neighborhood of. The fumes from these furnaces, which are largely sulphurous acid, are very destructive to wires, and a No. 8 wire will last only about three years. A letter was shown me a few days since, in which the party in charge there showed much nervousness in anticipation of bad weather. A piece of line wire which had been sent to the general office, showed that such fears were not without foundation, for this sample, which two years ago was either a No. 12 or 14, had been reduced to nearly a 20 when taken down.

Mr. Chas. Wirt, of the Edison company here, has lately made a small storage battery which has some peculiarities worth noticing. The cells are made of sectional candy jars, such as confectioners place in their show windows. These sections are each complete in themselves, and fit so that each makes a cover for the one beneath it. In the bottom of one of these he has placed a concentrically wound pair of plates of sheet lead, one of which is corrugated. The two strips, thus wound, give large surface, being an inch high and several feet long. The coil is about five inches diameter and rests in the bottom of the jar like a roll of tape. Upon this he placed four half-inch sections cut from an argand glass chimney. These serve for the upper plate to rest upon, and permanently separate the plates. Above this is the second lead coil, similar to the lower one. The whole is then thoroughly sealed in with shellac, save a half inch hole at the top, to allow hydrogen to escape. Two such cells are mounted, one above the other, and these are connected by insulated lead strips in series. It is easily inspected and clean, easily handled, and works very satisfactorily. Mr. Wirt says the internal resistance is greater than he anticipated, and that in future he will cut his glass supports of less height.

A recent letter from Prof. Barrett, Superintendent of city telegraphs, shows that a very general acquiescence in the demands of the city is noticeable, in the matter of underground wire placing. The W. U. Telegraph Co. have 75 miles already, and will eventually have about 500 miles buried. They have laid conduits from their office on Lasalle street to the new Board of Trade, and from Van Buren street south to the city limits, all of which, if the weather ever lets up, will be wired, and the line of poles down Clark street, belonging to that company and its adopted child the Mutual Union, cleaned out. The B. & O. having shaken off the old-man-of-the-sea injunction, which checked them, will proceed to fill their conduits at as early a day as practicable. The Bankers and Merchants are already buried—their wires, you'll understand—the Postal company has 180 miles underground, the Western Indiana has several miles, the City has about 60 miles and plenty more to go under early in the spring, the Telephone company has about 28 miles now under, and will bury more as fast and as far as is practicable, and the electric light companies will "go below" as their needs require. So that in a short time Chicago will probably lead in the matter of clearing up the pole and wire nuisance to a greater extent and more perfectly than any city in the world. His letter concludes: "Chicago was first to see the danger, as she was first to adopt a remedy for the cumbrous and daily increasing net-work of overhead wires, and has, I think, to-day, more miles of underground wire than any city in the Union."

The Dorsett system of underground electric conduits, which has been referred to in these columns, and which has been adopted by the city authorities for their wires, is the system that the Chicago Sectional Electric Underground Co. has also adopted, and is going to use in constructing a very elaborate and comprehensive "plant" as soon as the weather permits of the streets being opened. Mr. Dorsett's material is a composition of prepared asphalt, concrete, sand and other substances, the formula for which is patented and has been in use for several years for water and sewer pipes. It is as hard as rock and practically imperishable. It is made into cylindrical sections three feet long with a flange on one end, and of two sizes, one of 10 inches outside diameter containing seven 2¼ inch holes separated from each other by three-quarters of an inch of the material, and one of 16 inches outside diameter containing 19 2¼-inch holes separated as in the smaller size. These sections are bedded in sand, or other suitable material, in a trench, and the holes of one section are made perfectly true to those of another by inserting an expansion rod into two of the holes past the joint and leaving it in position until the two sections are united together. This is done by ramming some of the hot material into the space between the bell and spigot with a hot tamping iron, making a solid and homogeneous mass.

The manhole is made of the same material and resembles somewhat a large, short-necked, round bottle, the neck part being 26 inches in diameter, the body 44 inches in diameter and of any required depth up to five or six feet. These manholes are made in one piece and when set into position a portion of the side is cut out to let in the main conduit from two or more directions; and the joint is made with hot material, as between the sections, making the whole perfectly gas and water tight.

In the iron pipe systems with brick manholes, now in use here by some of the companies, the leakage of gas into the junction chambers has become a serious difficulty and has already caused several explosions. Escaping gas from the street mains cannot find a vent through the pavement and works along through the earth filling every space and cavity, often causing much damage, and Mr. Dorsett considers this gas-proof feature one of the principal advantages of his system.

The conduit, when complete, consists of a number of 2¼-inch holes through an excellent insulating material and strong enough to protect the wires from mechanical injury, while it possesses electrical advantages not found in any iron pipe or metallic system. The compound being a good insulator, the wires in the holes will be less subject to retardation troubles, as they will be further removed from the earth, and will be better insulated, for the same reason. The material is also non-corrosive and not subject to rust as in iron, and cables pulled into the ducts may be removed and replaced with great facility. The Underground company also proposes to lay six-inch pipes with a shelf through the centre for electric light wires and has already several hundred feet of both styles of conduit laid. Work was commenced late last fall and was suspended until spring on account of the cold weather.

People who use gas engines for various purposes of electrical import, often have fun from their fitty characteristics, especially when a telephone exchange is dependent upon these for actuating their generators. A misunderstanding of this nature on two or three occasions in Milwaukee, recently, occasioned considerable trouble. Without previous warning or apparent cause, the blessed thing would occasionally stop to rest. The gray-haired president was, as usual, equal to the task. Along the driving shaft of the engine he placed a flat, weak spring, with a sort of hammer head at the free end. Connected with an insulated ring on the axle-bearing is a circuit, embracing a battery and two vibrating bells, one in the manager's room and one in the operating room, and connected thence to the shaft and spring. While the machine runs, the centrifugal force tending to throw the spring off, breaks circuit; but once at rest the hammer head of the spring closes by settling on the ring in whatever position it may stop. "There!" said the inventor, when he had finished it, "if you will try to stop and shirk your duty, I'll have the satisfaction of making you give yourself away *every time*"—and it does.

CHICAGO, Feb. 14, 1885.

PHILADELPHIA.

A City of Underground Skeletons.—Councils Decline to Proceed Against Overhead Wires.—Proposed State Legislation Against Overhead Wires.—The Court Decides that a Telephone Company is a Telegraph Company.—Annual Meeting of the Franklin Institute.

ALTHOUGH councils have in the last seven years granted many companies permission to put down underground wires in this city, it would seem that generally the privilege was about all that the gentlemen who managed the various companies wanted, because in most of the cases, beyond paying the money for the ordinance, they have done nothing. The first ordinance passed by councils granting the permission bears date May 16, 1877. It allowed the Atlantic & Pacific Telegraph Co. to lay and maintain underground wires in the city of Philadelphia. This company shortly afterwards was absorbed by the Western Union, and never took advantage of its privilege. In November, 1878, the Brooks Underground Telegraph Co. was granted permission to lay a line of wires along Fifth street, between Chestnut and Cherry streets. These wires were never laid. The Municipal

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Telegraph Co., in January, 1881, had an ordinance passed, but never laid either wires or conduits. The Underground Electric Conduit Co. was allowed, on February 7, 1883, to put wires under Juniper, Broad and Merrick streets and South Penn square, but never did so, although the time in which it was to do it was extended by councils. The Morse Underground Co. was, on February 10, 1883, given until August 21 of the same year to lay a system of underground wires. It never did so, although it put down on private property 500 feet of wire for exhibition purposes. A company whose title was much longer than the wires it laid—The Metropolitan Underground Telegraphic, Telephonic and Electric Light Co.—received permission April 3d, 1883, but never did any work. The Philadelphia, Reading & Pottsville Telegraph Co. was authorized to lay a wire between Nos. 204 and 227 South Fourth street on June 29, 1883, and did so. The Continental Underground Cable Co. was given one year from July 7, 1883, to put down conduits and wires, but did not do so before the limit expired. There is an ordinance before councils now extending the time for another year. The Philadelphia Sectional Electric Underground Co. was authorized on July 12, 1883, to lay wires and conduits, and has laid about five miles of wires. It is this company's conduits that have been amusing themselves and startling pedestrians by exploding every once in a while. The Baxter Overland Telephone and Telegraph Co. was authorized on October 10, 1884, to lay wires and conduits on various streets of the city, but has done nothing yet. On June 21, 1882, the Brush Electric Light Co. received permission to lay wires and conduits. A line was put down on Delaware avenue, between Vine and South streets, but it proved to be a failure. On the same date the United States, or Maxim Electric Light and Power Co. also received permission, but never did anything. On March 21, 1883, permission was granted to the Baltimore & Ohio Telegraph Co. As yet it has done nothing, but the officers of the company expect to get to work in the spring. The National Underground Co. was granted permission on March 16, 1881. A cable was laid on Market street, between Front and Juniper streets. It turned out to be a failure, and only part is now underground, the rest having been torn up by the traction company. A. C. Yates & Co. have laid about 500 feet on Chestnut, near Sixth. Permission was granted them on February 7, 1883. Henry C. Gibson and others who use the Brooks system were granted permission on April 3, 1883, and have laid about four miles of wire, running from the Broad street station to Front and Norris by way of Third and Walnut. All of these companies are required to enter $20,000 security to the city that they will not consolidate; that they will pay their taxes; keep the streets in repair; be responsible for damages, etc. Up to the present time the only companies that have complied with this provision are the Brush, Philadelphia Sectional, and Henry C. Gibson & Co.

In comparison with the above showing in the matter of underground wires, it is of interest to see what Chicago has done in the same line.

At present there are down and in successful operation in that city 718 miles of wire, of which the Bankers and Merchants' Telegraph Co. own 400 miles; the Postal Telegraph Co., 150; the Chicago Telephone Co., 28; Western Indiana Railroad Co., 50, and the City and Fire Alarm Telegraph, 60. In addition to this, the Western Union will shortly have 500 miles down, and the Baltimore & Ohio 250, making a grand total of 1,468 miles of underground wires.

The greater part of the session of common council on the 12th of the present month was devoted to the discussion of the ordinance which proposed to allow the overhead telegraph wires to remain until January 1, 1886, instead of causing them to be placed underground at once. Some of the members fought the ordinance bitterly, and held that the companies had made no effort to take down their wires. It was moved that the consideration of the ordinance be indefinitely postponed, for the reason that the Legislature was now engaged in the consideration of a bill which, if adopted, would cause all telegraph and telephone wires in the cities of the state to be placed underground by the 1st of December of the present year. The legislative bill would render this ordinance inoperative. The consideration of the ordinance was thereupon postponed.

The bill above referred to as being introduced in the House of Representatives at Harrisburg, is as follows:—

SEC. 1. Be it enacted, etc., that all telegraphic, telephonic and electric light wires and cables used in any incorporated city of this commonwealth, having a population of 10,000 or more, shall hereafter be placed under the surface of the streets, lanes and avenues of said city.

SEC. 2. Every corporation, association or person owning, controlling or operating telephonic, electric light or other wires and cables, including what is known as telegraph poles and other appurtenances thereto, shall, before the first day of December, 1885, have the same removed from the surface of all streets, lanes or avenues in every such city of this commonwealth.

SEC. 3. In case the owners of the property above enumerated still fail to comply with the provisions of this act, within the time herein specified and limited, the local governments of the said cities of this commonwealth shall then, and they are hereby directed to remove, without delay, all telegraphic, telephonic, electric light and such other wires, cables and poles, wherever found above ground, within the corporate limits of their respective cities.

SEC. 4. No city in this commonwealth shall grant any exclusive privilege or franchise under this act to any corporation or individual, by which a monopoly may be created or competition prevented on equal terms.

SEC. 5. That any individual, firm, association or corporation, or any officer, agent or employe thereof, violating or failing to comply with the provisions of this act, shall be deemed guilty of a misdemeanor, and, on conviction, shall be punished for each and every offence by a fine of $1,000, one-half to be paid to the prosecutor and the other half to be paid to the county in which the conviction is had, and an imprisonment not exceeding two years, or either or both, at the discretion of the court.

SEC. 6. That all laws or parts of laws inconsistent herewith be and the same are hereby repealed.

Our state representatives and city councilmen seem to do a great deal of talking in reference to placing the wires underground, but I am inclined to think that the telegraph companies will be apt to nominate their own time in regard to the matter.

There are a half-dozen other companies after various privileges (chiefly underground) from the city, and as they are all likely to get what they want, it is to be hoped that they will be satisfied. But for the life of me I cannot see where they are going to derive any benefit from their privileges after they get them.

In the appeal of the Pennsylvania Telephone Co. from the settlement of the auditor-general and state treasurer, Judge Simonton this morning filed an opinion giving judgment for the commonwealth for $345.04, the amount claimed.

The tax was based on the report of the company showing its gross receipts for the six months ending June 30, 1883, to be $35,794.91, and under the provisions of the act of June 7, 1879, which imposes a tax upon the gross receipts of "every telegraph company" incorporated under the laws of this or any other state, and doing business in this commonwealth. The question to be decided by the court was whether the appellant was a telegraph company within the meaning of this act. The court reviews the subject at length, and in conclusion holds: "Both on the construction of the act under which the appellant is incorporated in connection with the taxing act and on general principles that appellant is a telegraph company, and as such taxable on its gross receipts."

At the annual meeting of the Franklin Institute, Col. Charles H. Banes formally presented to the institute the library of electrical science which was collected by the managers of the exhibition, to be kept as a memorial of that event. It is to be known as the Memorial Library of the Franklin Institute. The volumes, bound and unbound, number nearly 3,500, and embrace works of early and recent dates.

A resolution was adopted instructing the officers of the institute to take steps to obtain from Congress reimbursements for the outlay made by the institute in displaying the government exhibits.

Officers were elected as follows: president, William P. Tatham; vice-president, Joseph E. Mitchell; secretary, William H. Wahl, M.D.; treasurer, Samuel Sartain; managers, William Sellers, Hector Orr, Cyrus Chambers, Jr., Henry R. Heyl, Charles J. Shain, Charles E. Ronaldson, G. Morgan Eldridge and Hugo Bilgram; auditor, William B. Cooper; representative to the Pennsylvania Museum and School of Industrial Art, William H. Wahl, M.D.

PHILADELPHIA, February 15, 1885.

BOSTON.

The Work and Improvements of the Fire Alarm System.—Time Distribution.—Electrical Lectures before the Society of Arts.—Close of the Electrical Exhibition.—Electric Train Lighting on the New York and New England.—Combination of the Edison and Thomson-Houston Interests.—A Conflict of Opinion about Lighting at Newport.—Proposed Time Ball on the State House.—Reception to Mr. Daft at Providence.—The Hartford Electric Light Co.—Fluctuating Telephone Shares.

THE annual report of the fire department contains interesting statistics of the work and condition of the fire alarm telegraph. Circuits have been rebuilt and repaired and new armored cable laid. The telephone service has been greatly extended, so that now there are 57 telephones in use—all of the houses of the department being connected with headquarters. Fifteen new signal boxes have been put up, making 330 boxes now in use. The keyless door, which saves so much valuable time in giving alarms, has been applied to 26 fire alarm boxes, in addition to six in use before, 23 more of the doors are ready, and will be put on at an early day, orders having been issued to supply all the boxes in the city proper with them.

New apparatus has been provided, consisting of an 18-pen register, a bank of 18 relays and keys, and an annunciator for the same. The Serson & Kauffer battery has been purchased to supply all the circuits, in place of the gravity battery. In the opinion of the fire alarm authorities the Serson requires less attention and lasts longer, a saving of time and material. The department has strung 70 miles No. 9 iron wire, 4,000 feet kerite wire, used 3,000 insulators, and 650 feet 7-wire armored cable. The number of alarms during the past year was 793, larger than for any year previous. The fire losses have been $998,554, and the insurance $7,981,807. Notwithstanding the large number of alarms, no fires of magnitude have occurred. The fire department pays the Cambridge observatory $400 per annum for the meridian time, or as we now have, standard time, which is struck from all of the fire alarm bells. The observatory derives

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quite a revenue from this source, as all prominent watch dealers have a relay in their shops to give Cambridge time. The fire department has changed the bell and gong fire alarm signals as follows: First alarm, box number repeated twice; second alarm, 10 blows followed by the box number: third alarm, 10 blows twice, followed by the box number: general alarm, 12 blows twice, followed by box number. The changes consist in striking off 10 blows from the third and 12 blows from the general alarm, and providing that the box number shall follow the third and general alarms, as well as the second alarm.

Mr. George W. Blodgett, electrician, of the firm of Blodgett Brothers, manufacturing electricians, recently delivered two interesting lectures before the Society of Arts, at their new building, on the subject of recent improvements in "Electric and Interlocking Railway signals." Mr. Blodgett gave a *resumé* of the subject, taking up in course the various inventions, and closing with the remark that the subject was more complicated than would appear at first sight, and that many systems which worked well in small models or areas had made failures in actual practice. In his second lecture he detailed the leading systems in use, the Hall, the Union, etc.

Mr. W. J. Jenks of Brockton has also delivered a lecture before the Society of Arts, his subject being the "Edison Central Station Electric Lighting System." He explained the main principles of the Edison system and had an appreciative audience of experts and practical electricians. His particular object was to present the commercial aspect of the light produced by the Edison system. The lectures given by the Society of Arts this winter, on electrical subjects, have been of much interest, being usually by practical men.

The Electrical Exhibition closed January 24th after being boosted, petted and encouraged on all hands during the time of its existence. It was a feeble thing from its inception and should have been kindly stifled by its projector while a fetus.

The Trouvé battery and Woodhouse and Rawson incandescent lamps have been placed on the New York and New England Railway limited train, in the dining car. This is the same installation I noticed a few months ago as being applied to the Boston & Providence train. The company owning the Trouvé novelties in this country make these exhibits to show the public what they can do. I understand they are putting small installations into private residences; the battery is so portable and easy of renewal that it may well succeed in cases where gas cannot be obtained, or where a beautiful and elegant illumination is desired. The company do not say it is cheaper than gas at ordinary prices, or than oil lamps, but that it is better and safer.

The American Electric and Illuminating Co., have combined with the Edison people and are to use the Edison incandescent system for isolated lighting in connection with all of their arc lighting stations in New England, as well as with its isolated plants in the same territory. The Edison company with which the arrangement has been made, has the exclusive right for New England of putting in isolated installations of the Edison system. There is still another branch of the Edison parent company in Massachusetts, which also covers New England, for the purpose of organizing companies to light cities by the underground system. This branch has arranged with the American company to work in unison. This practically closes out any combination of electric light companies in this city.

Newport, R. I., has been exercised about the electric light question. There is a fight between the gas and electric light interests, the common council voted against the use of electric lights, and the committee on gas and lamps met to carry out the vote, but were confronted with a formidable list of petitioners praying for the retention of the lights. The aggravation of the thing is that two years ago by a popular vote the tax-payers decided by a large majority in favor of electric lights. The action of the council was secret and apparently in favor of the gas interest.

An order has been introduced in the state legislature to have a noon time ball dropped; the roof of the state house is the proposed location, a fine and sightly position, as the "gilded dome" can be seen from all points of the compass.

Leo Daft was given a reception in Providence, R. I., January 27th, by Mr. Wm. A. Harris and other prominent citizens of the state, who are interested in a company recently organized for the practical application of the Daft system for the electrical transmission of power. After the elegant lunch had been disposed of, Mr. Harris introduced Mr. Daft to the assembled company in a few well chosen and eulogistic remarks, whereupon Mr. Daft proceeded to give a review of the history of the development of electro-motive force from the days of Jacobi to the present time—including a detailed description of his own system. Gentlemen present who were familiar with the application of the Daft system gave the results of their experience in an interesting way. Subsequently the company took carriages and visited the Harris-Corliss engine works, where a central station has been established for the generation of electric power and its distribution by the Daft system, and they were then taken to offices a mile distant, where they were shown machinery in actual use, driven by power furnished through wires from that point.

The signal lights displayed at night from the flagstaff on the Post-office building by the United States signal-office consist of a lantern of thick glass, which is to have inside an electric light instead of the usual oil and wick.

The annual meeting of the Hartford Electric Light Co., was held on the 11th inst., the officers for the ensuing year being elected. The old board declared a quarterly dividend of 1½%. The company is earning 10% net above all expenses. It commenced business with 100 lights, since then it has increased them to 225, and will soon increase to 300. A complete central station of the Edison system will be added to the present arc plant.

The American Bell Telephone stock has suffered another sharp decline, running down to 208, and rallying to 217, where it has stood for some days. It looks now as though the shorts would have to cover, which will send the stock up again. The New England and Erie stocks act sympathetically with the Bell No one knows *why* the stock should decline and advance so easily any more than one can give the reasons for the actions of a coquettish young woman.

BOSTON, February 14, 1885.

WASHINGTON.

No Government Telegraph Action During the Present Congress.—Mr. Money May Carry His Scheme into the New Cabinet.—Charges of Inefficient Fire Alarm Management.—The Pan Electric Telephone.—The Baltimore & Ohio Company.—Another Underground Company formed.

THE closing days of the forty-eighth congress are at hand and as predicted in this correspondence, no action has been had in the matter of the control of the telegraphs by the government. At its opening there was quite a class in Congress, and out, who regarded "government control" as a sovereign remedy for all faults and abuses, whether by those who managed the telegraphs, the railroads, the banks or anything else. Reflection seems to have diminished this class here and elsewhere, and they are now apparently more willing "to bear the ills we have than fly to those we know not of." Mr. Money the chairman of the house committee on post-offices and post roads still firmly stands by his bill, previously noticed, and has only been prevented from pressing it by want of opportunity. He is now spoken of as a possible future post-master general under President Cleveland. Should he be selected, he would carry his ideas as to the telegraph with him, and possibly be able to impress them upon his associates in the cabinet. He is a man of much energy and force of character, and would be persistent in carrying out views that he believed after careful study were well founded. He is a man who would prefer to mark his administration of the office by an advance step in the march of progress rather than hunt the musty files for some evidence of delinquency on the part of his predecessors.

There is something of a stir among the local magnates over a recent charge made by the chief engineer of the fire department that the Fire Alarm telegraph, or its management, is inefficient. There has been a good deal of correspondence on the subject between the commissioners, Chief Cronin, and Supt. Miles, and a number of newspaper contributions on the subject. The trouble is alleged to have been crosses with telegraph, telephone and electric light wires. The remedy suggested by the parties to the controversy is the immediate substitution of cables for the overhead wires. This is also in line with the ideas of the commissioners who cannot well insist that the corporations bury all their wires while those of the district government swing overhead. The combination of circumstances makes it almost a matter of necessity for the authorities to set the example and test the experiment fully of a system of local underground wires. As the people are allowed no voice in the expenditure of their money there will be nobody to grumble if the experiment proves a failure.

The Pan electric people have put a pair of telephones on a single wire cable, running from the office of the sergeant-at-arms' in the senate wing of the Capitol to General Butler's house, just south of the Capitol grounds. The instruments are working well. I understand the Bell company are about to sue out an injunction for the infringement of the Bell patent as soon as the necessary papers can be made out. The Pan Electric Co. is a formidable one in names at least, having Genl. Joseph E. Johnston for president, Senator A. H. Garland (prominently named for the next attorney-general) as attorney, Senator Isham G. Harris, Hon. Casey Young, Col. R. F. Looney of Memphis, Tenn. and others, for directors. The nominal stock of the parent company is $5,000,000 and there are several local corporations with a nominal capital of from one to $4,000,000. Of the market value of these stocks I am not advised.

The experiment by the Edison company of lighting a portion of the senate chamber and lobbies has been eminently successful, and it is expected that the necessary money will be at once appropriated to substitute electric for gas light for that wing of the Capitol. The House end will await the result of the innovation.

The new building of the Baltimore & Ohio Railroad Co. to be occupied for railroad and telegraph purposes, work on which was delayed first by negotiations for the consolidation scheme and then by the weather, has been closed in and is being completed as rap-

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idly as circumstances will permit. It will be ready for occupancy early in the next month. The company has been forced to connect its wires by means of underground cables. The distance the cables shall be run has not yet been determined by the commissioners.

There has been a company incorporated here under the general incorporation laws of the district: The Capital City Underground Telegraph Wire Pipe Co., with a capital stock of $50,000 which proposes to manufacture and lay pipes in which to place telegraph and other wires. Among the corporators are A. Worth Spates and Thomas R. Rich of Baltimore, who are also interested in the Monumental Wire Pipe Co. of that city. The Washington gentlemen have not heretofore been identified with electrical interests.

WASHINGTON, D. C., Feby. 16, 1885.

NEW ORLEANS.

The Great Exposition Now in Full Blast.—How the Different Companies Share the Illumination.—A Dearth of Electrical Exhibits.—The Wire Manufacturers Well Represented.—Popularity of the Electric Railway.

THE Exposition is now on a boom. With the exception of a few machines, the electric plants are all complete and running; the buildings and grounds are open till 10 p.m., and the visiting throngs witness such a flood of electric light as has never been seen before. Over 7,000 electric lamps (arc and incandescent) continue the illuminating contract when the sun goes down. The Louisiana Electric Co. has been very busy, and but two or three of its 35 dynamos remain to be put up. Its initial efforts here displayed in lighting this vast building must inspire the stockholders with hope for the future, and perhaps, as a result, the remaining installments due on stock will be paid promptly and with pleasure.

The South-western Brush company is now running under full head of steam. Five 65-light machines furnish 300 lamps to the government building and a few to the grounds.

The Jenney company has its groups of 10 lamps hung in mid-air, as they appear to be, and are certainly attracting considerable public attention By a slip of the pen, I stated in my last letter that this company has *five* towers upon the grounds, when in reality there are *six*. The plant consists of three each 30 and 15-light machines now running, and two more 30-light to be put in. They furnish 66 lamps to the stock barns, 29 to the wagon building, eight to some of the walks in the grounds, and 15 to the Grand Rapids Furniture Pavilion. This last named building was to have been lighted by the Edison company, but for some reason this change has been made. In addition to the above, one Jenney lamp will be placed on the steamboat landing and two in the water-works building.

The Thomson-Houston company has two 30-light machines in Main Building, running in connection with four like dynamos placed in Machinery Annex, from which are wired 75 lamps in Horticultural Hall, 23 in Saw Mill Building and 25 in the Annex itself. Besides, they drive four Cleveland motors used by H. Muhr Sons, of Philadelphia, who manufacture souvenir gold rings. They are the only electric motors (the Daft Railway excepted) so far observed *in use* in the Exposition. An Edgerton motor on exhibition running a sewing machine is also run by this company.

The Philadelphia Exhibition, lately held, having shown what electric light companies can do in the way of attractive displays, we must say the exhibits (?) in this line here are, to draw it mildly, *tame*. The Edison company has excellently situated space, from the centre of which rises a group of colored lamps, producing a pleasing effect. Beneath, and under the shadow of its support, hangs a drop light, bringing out in perfect relief the various colors in a piece of patch-work placed below. A case of lamps ranging from one to 100 candle power, a sample of each of the 15 sizes of wires used in lighting the Art Gallery, a picture of the "Pilgrim," bearing the legend that she is the largest steamboat in the world, and carries the largest electric light plant afloat (960 lamps), a few sections of underground conduits, a motor and fan, and an armature—this about constitutes the Edison company's display.

The Jenney company, near by, displays a large case of Wallace diamond carbons, of great variety of sizes, and a miniature star tower, upon the top of which are to be placed three Edison incandescent lamps.

The Thomson-Houston Co. exhibit a number of arc lamps of different mechanical arrangements. A tastily arranged little office shows the Thomson incandescent lamp to advantage.

Electric exhibits in general are few and far between. Can they all have gone to Boston? Among other things, the Roebling company display hard-drawn copper and also galvanized wire for electrical uses.

The American Electrical Works of Providence show a great variety of insulated and lead-covered wires, telephone cords and aerial cables.

Bare wires, both copper and galvanized iron, enter into the very complete exhibit of the Washburn & Moen company. A thermostat, as simple as it is novel, and an electric bell, with constant ringing attachment, together form a local fire-alarm system, and is the electrical contribution of this city to the Exposition.

Electrically speaking, the golden glory of Music Hall, as seen from its main entrance, and the silvery beauty of Horticultural Hall, viewed from a distance, divide the honors (at night) of the Exposition, although the electric railway claims no small share of public attention. This connects the government and main buildings, the track being some 1,100 feet long, the equipment consisting of a Daft dynamo in Main Building, a motor and three cars. The "electric glide," as a trip over this, the first railway of its kind in the South, is called, is now one of the features of the Exposition.

The financial troubles under which the Exposition has been laboring have been felt by the electric light companies, as none of them have been paid anything up to date on their contracts. A draft of $5,000 of the Louisiana company accepted by the Exposition, fell due a few days since, but no funds being in hand with which to meet it 15 days' extension was asked and granted. Aside from this, the only other company heard from, has been the Edison, which has endeavored to procure payment by suggesting that no cash being forth-*coming*, their plant would be forth-*going*, but neither has occurred as yet. However the many clouds which have been hanging over this great undertaking seem about clearing away. With the increasing attendance and perhaps another appropriation from Congress all existing debts will be paid, a good financial status obtained and happiness reign alike among the creditors and board of management.

NEW ORLEANS, February 19, 1885.

COLUMBUS.

Defeat of the Resolution Supporting the Sumner Postal Telegraph Bill.—Alleged Fraud in Its Passage Through the House.—Final Disappearance of Its Friends.—The Regulation Underground Bill Sticks Its Head Up.

THE Ohio Legislature has just disposed of a resolution recommending the adoption of the Sumner Postal Telegraph Bill now before Congress, and instructing the Ohio senators to work for its passage. In the House where the resolution originated it was defeated but afterwards reconsidered, and upon the final ballot declared adopted by just the requisite number of votes. It soon transpired however that five names appeared upon the roll-call as voting *aye* when in fact four of the members were absent and one declined to vote. A resolution was at once adopted providing for an investigation with a view of ascertaining how the fraud was consummated. A committee has not yet been appointed to conduct the investigation and will probably not be—the House does not seem anxious to investigate itself. Yesterday the resolution was reported back in the Senate without any recommendation from the committee having it under consideration—the vote stood 27 to 0 against adoption. Not a friend of the postal scheme could be found in the Senate. Five speeches were made, strongly condemning the proposition for the government to engage in the telegraph business. The usual underground bill has made its appearance this session but does not seem to have many advocates.

COLUMBUS, O., February 19, 1885.

SAN FRANCISCO.

A Field for the Electric Railway.—Mr. Gamble's Mission Involved in Mystery.—The Western Union Delivery.—Legislative Raids on the Telegraph Tariffs.—A Rich Telephone Territory.—Mormon Interest in Electrical Affairs.—Overworked Telegraphers.—The Regulation Rumor of an Organization.

HAVE any of your eastern *savants* as yet practically operated an electric railway? If so, and such a man can give bonds he, can, I think, secure a good contract from one or more lines in San Francisco. The cable lines leading from the Ferry to the Park and the Mission are simply coining money. Parallel with this line, running mission-wards, are the Mission street, the Howard street, and the Folsom street horse railways, yet on account of better appointments and steadier gait the public prefer the cable. Some years ago Woodward, of Woodward's Gardens, and the owner of the Mission street line, experimented on an electric road but it proved a failure, why? Are our electricians behind those of Germany or even old Ireland? Gentlemen, here is a chance for you. Make your propositions to Mr. Woodward of the Mission line, Peter Donohue of the Howard street line, or Michael Skelly of the North Beach and Mission line. The entire route of the three is on a level, from the Ferry to 26th street or further. Prove, for the present, you can run as fast (8 miles an hour) and work it as cheaply as the Market street cable and you will find ready "takers."

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Mr. Gamble denies in a quiet way that he is here in the interest of the Postal company, but does it in such a mild manner that one would think, he but half meant it. One thing is certain, *he is here for something.*

I did Mr. John Barry an injustice when I said, most of the Western Union delivery was done by the American District System. I should have said the outside business, as only $\frac{1}{8}$ of the entire business is delivered by the District messengers. Jack being a veteran and a capable man, I make the *amende honorable.*

The Legislature now being in session, ambitious statesmen eager for renown and a grateful country's applause, are inventing all kinds of telegraph rate bills, one regulating a tariff by every 50 miles, another by a minimum and maximum rate, and another by a bill making it an incorporate part of the civil code, that in the event of a reduction being made to meet rivalry, that it shall not be in the power of the corporation to again raise said rate to its former standard without invoking the aid of the Legislature. Of course the superintendents of telegraph and telephone companies will be heard before the Committee on Corporations reports on them, and it is probable these bills will meet the fate of many a great scheme—die young.

Perhaps there are few districts in which the Bell telephone pays better than in that of Utah, Montana and Idaho, owned and operated by G. S. Erb, C. F. Annette and a few more gentlemen of Utah. J. J. Dickey, Sup't and A. J. Pattison, Manager of the Western Union, first started the telephone and district systems, and recently sold out to the above gentlemen at very high figures, when it was stated that the Western Union company compelled them to do so or else sever their connection with that corporation. Mr. Pattison is now managing the Drawbaugh system in Toronto, Canada, of which country he is a native. The Mormons are great patrons of the telephone and electric light and as many of the "Twelve Apostles" are shareholders there is no fear for lack of capital. The corporation covering this territory is the Rocky Mountain Bell Telephone Co., and on January 1st, 1885, it had 22 exchanges, with 1,460 subscribers, being an increase of seven exchanges and 452 subscribers during the year 1884. It also operates about 500 miles of extra-territorial and toll lines.

About 60 arc lamps are used at Ogden, and double that number in Salt Lake city.

The manner in which operators are worked at Ogden, Utah, if their stories be true is a shame. Men who come on at 6 p. m. and work continuously on heavy overland business until 5, 6 and 7, the next morning are again made to report at noon for lunch relief, and without a cent extra pay over the regular day's salary. In a measure, the night men here are similarly treated save reporting at noon, but these orders are not the fault of our managers, they come from Chicago. I have heard a rumor of an organization being started throughout the United States, through which operators would arrange through lawyers for suing the telegraph companies for damages caused by errors, when such errors were made by incompetent or overworked men. The operators here say the men in New York are allowed "extra," or a force sufficient to avoid the necessity of overwork is employed. Why is it not so all over? By hard work all around our men here are able to get off in time when the wires are working well, but when storms arise, as is frequently the case in winter, then the night men suffer. It is not for me to criticise, but I think a man who works 8 hours on an Overland circuit should be paid extra for every moment he works beyond that time.

SAN FRANCISCO, February 10, 1885.

ELECTRICAL NEWS AND NOTES.

TELEGRAPHIC OCCUPATION OF RAILROAD LOCATIONS.

SPECIAL REPORT OF THE MASSACHUSETTS BOARD OF RAILROAD COMMISSIONERS.

[CHAP. 59.]

RESOLVE relative to the occupation of Railroad Locations by Companies organized for the purpose of Transmitting Intelligence by Electricity.

Resolved, That the Board of Railroad Commissioners is hereby instructed to investigate the subject of the occupation of railroad locations by more than one company organized for the purpose of transmitting intelligence by electricity, including the necessity for and propriety of such occupation, the terms and conditions under which the same may be properly and safely permitted, the character and nature of the structures to be used, the regulation of their construction, repair, maintenance and operation, and to report to the next General Court the result of their investigations, with such recommendations and suggestions as they may desire to make. [*Approved May* 27, 1884.]

AFTER full notice a hearing was had under this resolve, and the question was argued, and testimony was introduced by able counsel representing the Baltimore & Ohio Telegraph Company in favor of legislation, and various railroad companies in opposition. No one appeared for the public or suggested any public demand for new legislation, nor did any one attend the hearing except the representatives of the above named corporations. The Commissioners regret the necessary length of this report; but when an important subject is referred to them by the General Court, it is a plain duty to investigate it thoroughly, and to report fully.

There is no serious question as to the power of the General Court to act upon this subject. Legislative authority over the railroad charters of Massachusetts is almost unlimited. Nothing is suggested as to any of these charters which forbids the legislation proposed. Nor can it be doubted that a franchise may be taken for the public good, in whole or part, as well as any other property; and land devoted by law to one use, has been, and may be, subjected to another use upon payment of damages.

An ingenious argument has been made to show that the proposed act would be void as conflicting with the United States Constitution and with Congressional action under it. It is said that the power of Congress to regulate internal commerce, includes the instruments of commerce, such as vessels, carriages and telegraphic lines. When Congress has acted, any state is ousted of jurisdiction, and *cannot even legislate in furtherance of the Congressional system.* But Congress has acted, first, by declaring railroads to be post-roads; secondly, by allowing telegraphic lines to be constructed on post-roads, and also by granting certain privileges to telegraphic lines.

Therefore the state cannot even aid Congressional action by giving power to locate telegraphic lines adversely. Congress has one scheme. The proposed legislation sets up a different scheme. And even an act not applied in words to inter-state telegraphy would be void as attempting to place under state jurisdiction telegraphic locations which are within United States jurisdiction, and which are connected with other lines extending through more than one state. And the case of Pensacola Telegraph Company *v.* Western Union Telegraph Company, 96 U. S., is cited. That decision, however, by no means covers the point in question. It was obtained by the Western Union Telegraph Company, then appearing as a progressive enemy of monopoly, and seeking to break up the exclusive right of an established company.

The court held that an act of Florida, giving exclusive rights to one telegraph company to construct and maintain lines in certain counties, was unconstitutional and void, as conflicting with the legislation of Congress on this subject. A decision that a state cannot exclude telegraph companies from its territory does not necessarily imply that it cannot admit them.

Nor has any case gone to that length, while many decisions take it for granted that states may lawfully allow the construction and, to a certain extent, regulate the operation of railroads and telegraphs, although Congress has legislated as to their location. It was said at the hearing that the acts of many states as to telegraphs were unconstitutional in this view. It may be added that the legislation of every state as to railroads would be set aside if this doctrine were sound.

The claim is that a state cannot by general law authorize the taking of a route for the construction of telegraphs, because Congress has by legislating on the subject deprived the states of jurisdiction. Applying this to railroads, Congress has undertaken their regulation (1) by the act of 1866 already cited, making railroads post-roads; (2) by an act of July 15, 1866, authorizing connections, and the formation of continuous lines; (3) by act of October 1, 1872, as to the transportation of live animals; (4) by acts regulating the span of bridges over navigable rivers. Therefore, the state cannot authorize the construction of a railroad by general, or special charter, especially if it connects with a road in another state, or with any road so connecting. Nor is it easy to see how it can legislate as to the operation of railroads even by requiring safety devices, if Congress by acting has acquired sole jurisdiction, and disqualified the state even from "supplementary legislation."

The answer to this whether as to telegraphic or railroad matters, is that Congress acquires exclusive authority, as to matters affecting inter-state commerce, only when it shows an intent to do so, and to regulate the whole matter; and that it has shown no such intent, either as to railroads or telegraph lines. On the contrary, the very act under consideration (sec. 5,263, Gen. Stats.) assumes that the state can establish telegraph companies. Its first words are: "Any telegraphic company *now organized, or which may hereafter be organized, under the laws of any state,* shall have," etc. One condition of the privileges conferred is, that the state shall have assumed jurisdiction to create a telegraphic company. And no intent is shown to prefer special legislation, or to confine the favors granted by Congress to companies that have acquired their rights with consent of the owners of the land taken for routes. The remark by the chief justice, in the case cited above, that the act of Congress only applies "whenever the consent of the owner is obtained," is a mere slip of the pen. Nothing of the kind is found in the act. To deprive the state of legislative power, there must be (1) an exclusive grant of power to Congress in the United States Constitution, or (2) an express prohibition of state legislation, or (3) an inherent incompatibility in the existence of joint jurisdiction, or (4) an intent to exclude state regulation. Neither of these exists here. And least of all is there an intent to deprive the state of jurisdiction in an act which grants a favor to

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a company upon express condition that it has secured state action.[1]

The power to pass the proposed act may safely be assumed. But the power to pass an act does not necessarily prove its wisdom or require its passage. All things which are lawful under the constitution are not expedient. Authority to create a new danger for all travelers does not necessarily imply a duty to exercise that authority. The question of expediency is not a question between the Western Union and the Baltimore & Ohio or any other company, nor between any telegraph company and the various railroads. It is solely a question of public convenience, including of course the highest kind of convenience—the public safety. It is true that the Board has heard objections to the proposed legislation from various railroad companies, and that their opposition may be grounded partly on the fear of actions for damages resulting from adverse occupation of their tracks. But the interest of the public to prevent accidents is infinitely greater than that of the companies to avoid suits. And the danger is not that of the companies, but of the traveling public.

The general right of imposing a new use upon land devoted to a corporation for a public purpose is precisely the same with the right to take any other land, neither greater nor less. It depends upon public exigency, and upon a balance of the gain and loss to the public in so doing. The idea that because land has once been taken for a public purpose, it may therefore be more readily taken for another, or that it may be so taken without a clear exigency, is akin to the common notion that the locations of railroads are public property, which leads so many to violate the law, and to risk their lives by walking upon the tracks. Four-fifths of the land in locations is owned in fee by the railroad companies. But as to the other fifth, their ownership, while they operate the roads, is as exclusive as that of any land owners. The right of taking, in whole or in part for a new public use, land already devoted to public use, for a railroad is, as has been said, the same in principle with that of taking a portion or the whole of any man's homestead, but with this difference, in the practical application of the principle. Taking the homestead only injures the owner, and his injury will be fully paid Taking railroad locations may endanger the public, and for this injury there is no redress. Instead of saying, "This land has once been taken for a railroad, therefore we can take it for a telegraph company," it would be more correct to say, "This land has been set apart for public use as a railroad: therefore you shall not take it for any other use, unless you can show that it will not endanger the public." This view is probably the reason why in England, where the public safety is more carefully guarded than here, no telegraphic works are permitted to be placed on railways without the consent of their managers, except that the postmaster-general may use locations for such works, when railway companies are unable or unwilling to do so.

There is no doubt that it is desirable to have in every great centre of business independent telegraphic lines, not only as a means of insuring better accommodation for the public, and cheaper rates, but as a protection against the danger of having news suppressed, or false news transmitted, to the profit of telegraphic managers, and to the injury of the public. Such a result is probable, where exclusive control of telegraphic news is given to one corporation; and when through the virtue of managers or from any other cause the evil does not arise, it is still suspected by the community. Possibly this evil can be finally cured only by governmental telegraphy. But the need of rivalry does not necessarily prove the necessity for occupying railroad locations.

It is supposed that cheaper facilities may be supplied by the cheaper construction and operation of telegraphs upon these locations. Assuming that a hundred dollars per mile, or a little more, may be saved in the work of construction, it should be remembered on the other hand: 1. That the land damages would be far greater than those resulting from construction outside of the location or on the borders of highways. The right of way in such cases can be procured at very low rates. The right of way from Eastham to Taunton, 70 miles, was obtained for less than 10 dollars. This is not likely to be repeated; but it is clear that land within a railroad location will be far more costly than the average out of a location. It has already been purchased or condemned at a high, perhaps an exorbitant, rate. The annoyance and risk would be considered; and no railroad company would be willing to have its location so occupied without payment of far more than $100 per mile.

2. The idea of cheap construction is founded partly on the belief that the occupation of a track would carry with it the right to deposit materials between stations. And this is a separate element of danger. The views of the Board upon this point were set forth in a report of May 17, 1884 (Baltimore & Ohio Telegraph Company *v.* New York & New England Railroad Company): "It is no doubt true that in the infancy of railroads, when little business was done, certain kinds of freight, especially cordwood and manure, were received and delivered at other points than stations, and that as a favor in special cases, building materials were sometimes so delivered. But it is also true that as railroads increased their traffic, and as their managers increased in knowledge, this practice ceased to exist. And it is hardly necessary to say that on crowded roads the delivery of freight at points which are not stations, and which are without side tracks, is not only a hindrance to business, but a great cause of danger. An occasional favor of the kind referred to would not be a foundation for a request that the practice be extended, but it might well lead to a recommendation by the Board that it should be stopped. While the scattered instances of freight delivery between stations do not make a precedent for demanding such delivery as of right, it is plain that a recommendation made under the statute, founded on exceptional cases, would constitute a precedent. And this, if followed up, would seriously obstruct and endanger travel on our railroads." This right of delivery between stations has not been granted by general laws upon the subject, and it is not given by the laws of Ohio and Louisiana to which we were referred by counsel as models.

3. It is a question as to whether inspection of telegraph lines can best be done on a railroad or on a highway, and upon this and other points we have the report of an expert whose standing and experience give great weight to his opinions. This is appended in Note A.

4. In considering the proposed advantage of constructing and operating telegraphic lines on a railroad track, we should remember that the public, while it must lose something in safety, may gain nothing in convenience or in cheapness, unless it is secured by legislation. No such legislation has been suggested by the advocates of a new law. The general question of cheapening by competition will be considered hereafter. The proposed legislation on its face only aims to relieve new corporations from pecuniary expense at the cost of increased danger to the whole traveling public. Even this object would not, as we believe, be accomplished.

The chief objection to allowing the adverse possession of railroad tracks by an indefinite number of telegraph companies lies, as has been intimated, in the increased danger to travelers. And it must be remembered that the advocates of legislation do not ask merely that a second line may be placed on railroad routes. Their whole theory, their proposed act, and the statutes to which they refer, provide for an unlimited number upon each railroad.

It needs no testimony to show that the erection of poles is a source of danger on a track. And this is at present the mode of using wires. It is also the mode adopted by those who ask for legislation. They are dangerous as possible objects of collision, as obstructions to vision and as distracting the attention of locomotive engineers. By falling they have caused fatal accidents; and more frequently such accidents have been narrowly escaped. A long list of casualties has been furnished to the Board in a report from the road department of the Boston & Albany Railroad Company (Note B), but without any such record, common sense would show the possibility of trouble from this source. It is said that all these accidents were not reported to the Board when they occurred. Some of them were not required to be returned. But the question is not whether they were made known, but whether they occurred, and are liable to occur again. The public are not to be deprived of their right to be protected against a danger, because the servants of a corporation failed to make it known.

It is asked, if one line is permitted, why not more. Simply because two obstructions on a road are more dangerous than one: and danger increases in more than arithmetical proportion with the increase of obstacles to vision. Or if an additional number of wires be used on each pole, then the danger of falling, especially when loaded with snow or ice, is increased. The number of poles on every road should be reduced to a minimum. It is now proposed to increase the number indefinitely.

It is said that a few roads have more than one line, and if this causes danger the second line should be removed. If the second line is not needed, this ought to be done; but its existence is no reason for forcing upon the road a third and fourth, and an unlimited number of lines, each of which is confessedly more or less a source of peril. Especially would this be unjust when the roads in question are already contemplating the removal of the extra lines.

It is said in answer to the objections of railroad men, that wires may be buried underground. For the purpose of this case it might be enough to say that no legislation has been proposed here, or adopted in other states, requiring such a disposition of wires. But the Board has devoted some time to considering the question whether this is practicable. The problem is interesting not only from its bearing upon the matter before us, but because it concerns the safety of our streets, now impeded and endangered by the almost intolerable nuisance of telegraphic poles and wires. It is well known that in various places, especially in large cities,

1. The chief authority for the exclusive quality of Congressional legislation is found in Prigg *v.* Pennsylvania, but the decision by no means requires the claim. The doctrine of the case on this point is much weakened by the dissent of three judges, including the chief justice. The controlling motive of the majority seem to have been an excessive and superstitious veneration for that portion of the United States Constitution relating to the return of fugitives, which made a state act in aid of Congress appear like the presumptuous crime of attempting to steady the ark. The decision itself, which set aside a statute that would nullify a clause in the Constitution, and an act of Congress is by no means an authority for setting aside a state law consistent with an act of Congress.

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telegraphic and telephonic wires have been laid underground. As early as 1837, Prof. Wheatstone's subterranean wires were at work between London and Liverpool. And the first important line in America was in part laid under the earth. Movements now pending for subterranean construction in New York, Philadelphia, Washington and Boston, will throw much light upon this question. Inquiries were addressed to the representative of the Western Union Telegraph Company, and a very full and interesting reply was made in print, from which extracts are given in Note A. We believe that the practical work of laying out and operating subterranean telegraphic wires will prove less difficult than is anticipated. Through the courtesy of Hon. Leopold Morse, M. C., we have received additional evidence on this point, afforded by the experience of government officials. A portion of this testimony also will be found in Note A.

The conclusion which the Board has reached on the point is, that it is very desirable that all telegraphic wires on railroad routes should be laid underground; that owing to the expense and to the difficulty of operating and keeping them in repair, this is impracticable now on long routes, although we incline to believe that it can and should be done in the streets of cities. It may be that at some future time the way will be clear for compulsory legislation, forcing all telegraphic wires on railroads to be so laid; but it would be wrong and foolish to order this now when so many hopeful experiments as to insulation and other improvements are in progress, and when so much remains to be learned as to methods.

These views, if correct, dispose of the argument that streets will be relieved by the free use of railroad locations. The relief in any event would be small. The long routes from place to place are not through streets. Wires leading from stations to business centres will still encumber the streets, and would not be diminished in number by the legislation proposed, and they will continue to be sources of annoyance and danger until the law compels their owners to place them underground. Then the streets will be relieved without any legislation as to railroads.

The possibility of burying the wires is considered here, as it affects danger arising from the use of poles. But the dangers of joint occupation of railroads by several companies do not all spring from this source. One chief object of the legislation proposed is to secure the opportunity to inspect and repair wires. It is hardly necessary to point out the inconvenience and danger of such joint occupation by several parties. The ideal of railroad operation is the exclusive use of the track by one managing and operating head. Every departure from this is a source of danger. When there is a necessary exception to this rule, as at grade crossings, it is a misfortune, and is attended with sad results. The presence of anybody who has a right to use the track for any other purpose than its operation is an evil. The presence of several parties is an aggravated evil, and it would be made worse by the fact that they were rivals and enemies, as would often be the case.

The dangers to be expected from joint occupation and divided management of a railroad track are illustrated by a law of this state. When railroads connect, each has a right under certain circumstances to have its traffic go over the other. It would be a convenience to each if its locomotives could pass over the other road. But knowing the dangers that would result, our law wisely forbids this, except by consent of the road to be so occupied. Joint adverse occupation would be a convenience to the corporation, but it is forbidden because it would be a peril to travelers. And in a single instance where the state has departed from this rule more than one fatal accident can be traced directly to this cause. The management of a railroad track should be exclusive and autocratic; not for the sake of the company but for the safety of travelers. It is possible that a law enforcing the use of underground wires might diminish the anxiety of telegraph men to build on railroads. It certainly would not remove the objection of railroad managers to having their locations occupied by independent and sometimes hostile parties. The necessity for occupying the track for inspection and repairs would still be a source of annoyance and peril. We repeat that sole and exclusive tenancy is the safe rule. This is hardly violated when by agreement the railroad company allows one company the use of its tracks, by which it conducts a joint business with the railroad company, each lending the other its wires on occasion, and working in the harmony of partners, but with inspection and repairs controlled by the railroad authorities. The rule would be at an end if an unlimited number of such companies were allowed to force their way upon the track.

It seems that the call for this legislation is not an existing practical evil, so much as the theoretical objection to what is called a monopoly. And this feeling is strengthened by the fact that one company, the Western Union, has exclusive contracts with many railroad companies in this state. But zeal against monopoly will not blind wise law-givers to the dangers that would arise from the indiscriminate use of railroad tracks by telegraphic lines. The motive of the Western Union is selfish, but the result may be beneficial to the public. And the railroad companies in securing to themselves immunity from loss promote the public safety.

It is hardly necessary to say that the exclusive contracts are no bar or hindrance to legislation. The views of the Board as to an alleged preference given to the contracting company in the distribution of telegraphic material are given in Note C.

In all of these contracts the exclusive claims are limited by the words: "So far as the company may legally refuse"—"So far as may lawfully be done"—or the like. And if these exceptions were not expressed they would be implied by law. No railroad company can bind itself to refuse facilities which by common law, or by statutes, are secured to any applicant. The state itself cannot secure to one company exclusive telegraphic facilities on a railroad track, as was held in the case already cited.

It is unnecessary to discuss this view of the subject, or to quote the cases in which an exclusive grant of a right to one railroad route has been held to be void, because no one will contend that any possible contract with the railroad companies of this state could hinder the Commonwealth from granting a right of way to other parties. No Massachusetts corporation claims the power to nullify in advance a state law. And this question should be considered precisely as if no such contracts had ever been made.

But if the Board is correct in its views, each railroad company without any contract upon the subject, would still refuse a second telegraphic line, and would act rightly in so doing. There is no difference in action between the companies that have contracts with the Western Union and those that have not. A company cannot bind itself not to admit telegraphic rivalry if public interests shall be found to demand it. A company without any contract should refuse telegraphic rivals if the public good demands such a refusal. It is an error to consider the exclusion of rival lines as an unjust preference to the first occupant of the track. The railroad reason for having a telegraphic line at all is the need of having it for the due operation of the railroad. Its reason for not admitting a second line is that it is not needed for the road, and would be dangerous to its customers. The commercial use of it, however great, is, so far as the railroad is concerned, incidental. In bargaining for such mercantile use, the railroad company obtains wires for its own use cheaply and conveniently.

Moreover it obtains for the public such accommodation as could be gained in no other way. On the Old Colony Railroad, for instance, 133 places, some of them wholly insignificant, are under the contract furnished with telegraphic facilities and enabled to reach all parts of the continent. Their gross annual receipts average only $144.03. This accomodation for the public could be gained in no other way than by the present system. The roads need one operator at each place; and by combining with the telegraph managers and by sharing the expenses of good and poor places, can furnish all with facilities. On another road, the Boston & Maine, the returns show at certain points receipts for the month of June, 1884, $5.90, $2.01, $1.50, $0.50. Only by the system which is called a monopoly could these telegraphic offices have been maintained. And few as the messages are, the possibility of sending them may have been of priceless worth to some of the senders.

In many small stations there is room for one operator, but not for two, least of all for two or more rivals. For it need hardly be said that two hostile operators would need more than twice as much room as one operator. Sharing this small local business with an indefinite number of parties would make it worthless, and it would cease to exist. And so, the good of the people would be sacrificed to the selfish demands of corporations. The people of these places will need more than the word "monopoly" to persuade them that for them the system is not a good one.

If it is said that the motives of the railroad corporations are also selfish, the answer is that the legislature should consult, not the motives of any corporation, but only the welfare of the public. A selfish company that promotes the welfare of the community should be encouraged. A selfish company that hinders it, should not be encouraged. And certainly a great public convenience should not be cut off simply because it is also a convenience to certain corporations.

If it is asked, how the monopoly made possible by this exclusive use of tracks by one company is to be avoided, the answer is:

1. No monopoly exists. There are in operation to-day four companies connecting between New York and Boston.

2. No monopoly ever existed arising from the privilege of using railroad locations. The highways of the state furnish, under the law, avenues for telegraphic communication. Its old turnpikes are especially available, and have been freely used. If monopoly ever existed it is not because the entrance of rivals has been forbidden, but because they have sold out to the strongest company.

3. If serious evils are felt arising from the limited number of telegraphic companies, it would be well to remember that unlimited competition is not the only cure for these evils, but that state control may be applied as a remedy. Without fully discussing this point it is enough to say that a great change has taken place in public opinion as to the policy of dealing with monopoly in railroad matters. Formerly, if a railroad 40 miles long ran from A to B and if its charges were too high, the remedy was to build another road between these points, at an expense of more than $2,000,000. And in time, one of these roads was bought up by the other, and the public had to support both. This costly and

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clumsy method is now discontinued. The quicker, cheaper, and simpler remedy is to make complaint, and procure a reduction.

The power of the courts, acting under state or national legislation, to enforce reasonable prices and facilities cannot be doubted. The doctrine of the United States Supreme Court is that, "when private property is devoted to a public use, it is subject to public regulation." (Munn *v.* Illinois, 4 Otto, 113.) This doctrine, which was applied two centuries since by Chief Justice Holt to the common carriers of that day, has been often enforced against railroad companies, and has been extended by our highest tribunal to warehousemen and to the owners of grain elevators. Without doubt it covers telegraphic companies, which are regarded as "common carriers of intelligence." And in Massachusetts this has been expressly decided in Pierce *v.* Drew (136 Mass., 75-77): "The transmission of intelligence by electricity is a business of a public character to be exercised under public control, in the same manner as transportation of goods or passengers by railroad." The propriety of state supervision and regulation of telegraphs and telephones, with a view to the securing of proper charges for service, is one of great and pressing importance. It is only referred to here to show that it is a more effective way of preventing the dreaded evils of monopoly than the method proposed.

4. If the absence of rivals ever leads telegraphic managers to refuse proper rates, and to deny to the public proper facilities, and if state supervision is not favored, it seems that the best remedy would be found by chartering one or more rival companies upon such terms as would guarantee such rates and facilities. In such charters, conditions could be annexed to the grant securing to the public the facilities to gain which these charters would be granted, and especially securing the public against the buying off, or absorbing, of the new company by the old. Thus assurance could be had that the public good sought should not prove to be a delusion.

The great power of eminent domain, under which a right of way can be condemned without the landowners' consent, whether in the hands of an individual or a corporation, is safe in the hands of the legislature. When application is made for a grant of the right to use this power, the General Court is the best judge of the exigency, of the feasibility of the route, of the responsibility and honest intention of the petitioners. It can decide, among other things, whether the object is to serve the public, or to levy "blackmail" upon existing companies. And this last consideration is especially important regarding the wisdom of a general law for telegraphic companies, because such companies, if so disposed, would have a double chance of extortion,—one with the telegraphic line which they proposed to rival, and another with the railroad line which they threatened to embarrass. (We need not say that these remarks do not apply to the gentlemen who are urging legislation, but the law, if passed, would apply to all persons.)

The rule in this state has been to legislate specially when the right of eminent domain must be exercised. The chief exception, a general law for railroads, was supposed to be demanded on account of the conflicting claims of various projects, and because of the constant draft upon the time of legislators.

Whether this act were wise or not, it has been found necessary to modify it essentially, after great loss to investors, and great injury to landowners. The cause which led to its enactment does not exist in relation to telegraphic companies. Until some exigency is shown, it would seem wise for the representatives of the people to retain in their own hands, the great sovereign power of taking property without the owners' consent, and not to delegate it to any inferior tribunal,—least of all, to intrust it to the interested parties.

It has been suggested that telegraph companies might be authorized to take land near the route of railroads, if it were not thought advisable to place them on the location. This question only arises now as a means of avoiding the danger of intruding upon railroad locations. No proof has been offered of an exigency for such a law, or of any difficulty in obtaining a right of way by bargain. The Board, therefore, does not discuss this scheme, which certainly would be far preferable to one encumbering our railroad tracks with new sources of danger. But having regard to the safety of the traveling public, the Commissioners decidedly decline to recommend any general law allowing the compulsory occupation of railroad locations for telegraphic purposes.

To persons not familiar with railroad operations, the objections of railroad managers to the proposed legislation may seem exaggerated; but so do many of their precautions against possible accident. Small obstacles, slight acts of negligence, errors apparently trivial, produce consequences out of all proportion to their apparent importance. Nothing is more common than to hear rules of precaution denounced or ridiculed by the very men who, after a fatal casualty, condemn railroad managers for not enforcing those very rules more strictly. Exceeding caution has been stimulated by many sad disasters. While the public rightly holds railroad managers to extreme care in the transportation of passengers, it should be willing to listen to them when they ask that they may be allowed to carry their passengers safely.

THOMAS RUSSELL,
EDWARD W. KINSLEY,
EVERETT A. STEVENS,
Railroad Commissioners.

December 31, 1884.

(Notes A, B and C, forming an appendix to this report, will appear in our next issue.)

TELEGRAPHIC COMMUNICATION WITH MOVING TRAINS.

Over a hundred guests availed themselves on February 15th of invitations extended by the Phelps Induction Telegraph Co., to witness a practical test of Lucius J. Phelps's system for electrical communication with a moving railway train. The necessary appliances have been made on the Harlem River branch of the New York and New Haven R. R., and the visitors were conveyed by special cars to its junction with the main line at New Rochelle, N. Y. Upon the down trip to the Harlem river terminus, many passengers availed themselves of the company's request, to write messages addressed to themselves, which were placed in sealed envelopes and handed to the station operator, to be subsequently telegraphed to the moving train on its return trip to New Rochelle.

The system by which communication is established is based upon the familiar principle of induction. The main line consists of an insulated wire, placed in a continuous protecting box, located midway between the rails. The experimental circuit now in use is 12 miles in length. For this a battery current of about 1½ ampères is employed.

The train apparatus is connected in an induction circuit composed of 90 convolutions of No. 14 copper wire, contained in a 1¼ inch rubber hose, the whole passing through a two inch gas pipe, suspended about seven inches above and parallel with the track wire, continued through the body of the car above. The total length of this wire is about 1½ miles, and that portion of the coil placed near the track is extended as far as the dimensions of the car will permit in order to obtain the best possible effect. The car circuit is actuated by a 5-cell Leclanché battery, one jar of which is used for the local sounder. The induced pulsations from the track are conveyed to a very delicate polarized relay, so arranged by Mr. Phelps as to be practically unaffected by the jar of a moving train. The current passes through this relay, the front contact of a pole-changing key, and a "buzzer," the continuous humming of which is divided by the key into Morse characters. Although it has been found possible to utilize a relay for receiving purposes at the terminal stations, a heavy battery was required on the car, consequently a telephone has since been substituted for the use of the receiving operator which serves the purpose admirably.

Quite a number of experts, perfectly familiar with the Morse alphabet, loitered about the instrument compartment, to hear the messages come in. Among them were A. S. Brown, Gerritt Smith and George A. Hamilton of the Western Union, Henry Van Hoevenbergh and Wm. Maver, Jr., of the Baltimore and Ohio. They were perhaps disappointed in hearing only the address of a single message "J. D. Barton." All of these gentlemen were however so thoroughly accustomed to temporary failures of new apparatus, that they did not question the eventual perfection of the system. Suggestions as to faults were freely made. The jarring of the car and the fluctuating distance between the car and track circuits were mentioned, while the inventor attributed the difficulty to undue strength of the main battery. Had a telephone been used as a receiver on the car it was generally thought that the messages might have been read by the operator without difficulty. Transmission from the car to the station proceeded without apparent interruption during the trip. It was said that the system had been working satisfactorily during the previous two weeks, and those present were requested to make a future examination of its merits.

ELECTRICAL REGULATION OF TEMPERATURE.

A very interesting practical demonstration of the application of telemetry, has recently been made at Rev. Dr. Paxton's church on West 42d street, between 5th and 6th avenues. During the past year $60,000 have been spent upon the renovation of this edifice, and special attention has been devoted to the ventilating and heating apparatus. In order to obtain a full supply of fresh air, a ventilating shaft of solid masonry was erected at the northern extremity of the building. By a series of shafts, operated by cranks in the sexton's pew, currents of warm or cold air could be admitted as required through inlets arranged under the pew entrances. Ordinary thermometers were suspended in different parts of the church, but as these were not accessible at all times, without disturbing the services, Mr. Heber R. Bishop, one of the leading trustees, suggested the introduction of Hewitt and Clarke's system as applied to telethermometers, described on page 265 vol. iii of

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this journal (December 1884). The transmitting thermometers are located on the right and left floors and corresponding galleries, and electrically connected with indicators and recorders placed in the sexton's pew, marked respectively, floor right, floor left, gallery right, and gallery left. It is obvious that a single degree of change in the temperature is at once registered, and the desired regulation made accordingly, thus preserving equable warmth throughout the building, which has heretofore been a difficult problem especially where a large number of people are assembled. Considerable amounts of money are frequently expended upon the sanitary fittings of fine buildings of this character, without accomplishing one of the most desirable results, that is, providing for the comfort of the occupants by protecting them from those violent changes so frequently prejudicial to the health of the strong as well as the weak. The adoption of improvements of this character should be heartily encouraged.

TELEGRAPHERS' BUILDING LOAN AND SAVING INSTITUTION.

In order to foster the accumulation of wealth, and provide unquestionable investment for the same, some of the most reliable gentlemen connected with the service of the Western Union Telegraph Co., have organized, and secured a charter for the "Serial Building Loan and Savings Institution." It is based upon a plan similar to those which have been so successful in Philadelphia, and is incorporated under the laws of New York and New Jersey. Its avowed objects are the encouragement of savings, and the assistance of its members in acquiring homesteads. The shares have been fixed at a par value of $200 each, upon which monthly installments are paid of $1, each. The money thus accumulated is loaned to stockholders only at 6% interest payable monthly, one share of stock being pledged for each $200 borrowed. Statistics show that stock in building associations of this character reaches its par value in from eight to ten years, according to the demand for loans. These associations offer perhaps the best and safest possible investment for wage earners. Although this institution has been organized by and among telegraph men, its shareholders are not restricted to that fraternity. Among the officers are, James Merrihew, President, M T. Wilbur, Treasurer, William B. Marsh, 172 Pearl street, Secretary. Any of these gentlemen will furnish further particulars to those seeking information.

THE NEW YORK ELECTRICAL SOCIETY.

At the regular meeting in the Cooper Union building, Feb. 25th, Henry A. Sinclair, of the U. S. Ordnance Ground at Sandy Hook, gave a very interesting account of the practical application of the Boulanger chronograph.

This is the instrument by which the velocity of shot is tested. It has been in use by different governments for 10 years. Mr. Sinclair had prepared a square wooden box about 10 feet long to one end of which was affixed a target. When a revolver was fired at the other end of the box, the bullet cut a wire at the muzzle of the pistol and another wire in the target which the bullet struck. The first wire cut a circuit and liberated a weight in the chronograph. Another circuit was cut by the wire in the target, causing the falling weight to be caught and marked, by which means the calculation was established. The pistol was of 45-calibre and the first shot showed a velocity of 156 feet a second the second shot 207 feet a second, the difference being due to the variance in the amount of powder in the cartridges. Mr. Sinclair said that by the chronograph a velocity of the five thousandth part of a second could be measured.

It is now used, he explained, in testing the velocity of the heaviest shot, and had resulted in the most accurate knowledge of the capacity and limits of different kinds of ordnance. Had Commander Worden, of the Monitor, had the benefit of these results, Mr. Sinclair said, he might have increased his charge of powder with impunity, so that one of his guns would have sent a ball tearing through both sides of the Merrimac. The heaviest guns on one of the Italian men-of-war recently sent a 2,200-pound shot at a velocity of 1,800 feet a second with a force sufficient to crack and break a 24-inch plate of combined steel and wrought iron. This was the heaviest defensive armor that has yet been prepared for ironclads.

At the next meeting of the Society, March 11th, the annual election of officers will take place.

ANOTHER TIME TELEGRAPH PROPOSED.

A public exhibition has been given at 18 Broadway of a system for the distribution of standard time by the use of electrical mechanism, devised by C. A. Mayrhofer of Vienna. Practically the proposed plan is to secure the same results as have been so well accomplished by the Time Telegraph Co., in this city. A rival organization is wholly unnecessary, and may perhaps be considered an evil in this particular field. Experience shows that there should be but one system of standard time, which when generally recognized, even if wrong, is preferable to two or more systems varying only slightly from each other. Fortunately there can be little encouragement for a new enterprise of this kind, and the public can remain in comparative contentment under the existing arrangements which have proved very satisfactory up to the present time.

DUPLEX LITIGATION IN ENGLAND.

Dr. Muirhead brought an action sometime since against the Direct United States Cable Co., Limited, to recover the amount claimed to be due for rental of his patented duplex system of telegraphing for a certain period during which, in consequence of defects in the cables, the system could not be worked. The case came up on January 19th on an appeal of the defendant company from the decision of Mr. Baron Huddleston in favor of complainant. Having heard the arguments of the counsel for the defendants, that the cables, though slightly defective, would yet carry messages on the simplex system, the Master of the Rolls expressed himself clearly to the effect that the fault was in the company's cable and not in the duplex system, which was now as good as ever, and held that Mr. Baron Huddleston was right in his decision. Lords Justices Cotton and Lindley concurred, and judgment was given against the appellants.

EXAMINERS' REPORTS ON THE PHILADELPHIA ELECTRICAL EXHIBITION.

The reports of the various boards of examiners, appointed in connection with the Philadelphia Electrical Exhibition, are being published, as completed and authenticated, first as supplements to the *Journal of the Franklin Institute*, and afterwards separately in pamphlet form. They may be obtained upon application to Secretary W. H. Wahl, at prices varying from 10 to 25 cents each according to size.

ELECTRIC LIGHT AND POWER.

Domestic.

The Houston (Tex.) *Chronicle*, of Dec. 31, in detailing the storms of the previous night said: "The lightning prostrated several electric light poles in the First, Fourth and Fifth wards, smashing lamps and globes. At the electric light works the lightning played havoc with the plant, burning three dynamos out in two nights. Two extra or reserve machines were also struck by lightning, putting out every arc light in the city."

An electric light plant is to be established in North Attleboro, Mass., the requisite number of subscribers having been obtained.

The incandescent electric light is meeting with a large and increasing field of usefulness in flour mills, where it has many points of advantage. The Park, Eagle and United States mills of St. Louis are among the latest to adopt it.

The following are the various bids submitted by the gas companies of the city of Brooklyn for the public lighting of that place during 1885:

	Street Lamps.	Public Buildings.
Brooklyn Gas Light Co., each per annnm..	$19.80	$1.50 per M.
Williamsburgh Gas Light Co., each per annum	21.75	1.75 "
Peoples; Metropolitan; Nassau and Citizens Gas Light Company, each per annum.	22.00	1.75 "

For the first time in the history of Brooklyn proposals were made to supply arc illumination for the streets. The propositions were handed in by representatives of the Brooklyn and Municipal Electric Lighting Companies—the former to furnish the Western and the latter the Eastern Districts of the city with such lights as might be awarded them.

The Pennsylvania Railroad Company is making experiments at its shops at Altoona with electric lights for use in its passenger cars. The experiments have progressed so favorably that it is believed that within a few months the electric lights will be introduced into all the passenger cars on its various lines.

The Daft Electric Light and Motor Co. has purchased the Gunther property at Ravenswood, Long Island, and will immediately build shops.

Isolated plants have been placed in the new Montezuma Hotel at Las Vegas, N.M., and Henck's Opera House at Cincinnati, which will be operated by the Westinghouse automatic engine.

Foreign.

Temesvar is the first city in Europe to have its streets lighted throughout by electricity.

Fire in the premises of the Edison Electric Light Co. on King William street, Hamilton, Ont., recently caused $5,000 damages.

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An electric light plant is being put down by Messrs. Heenan and Froude of Manchester, for lighting railway carriages on the Great Eastern Railway. Seven trains have been running since the 1st of October without a hitch. The dynamos are driven by Messrs. Heenan & Froude's high-speed spherical "Tower" engines, engines and dynamos being 3 ft. 3 in. long over all, by 13 in. wide and 2 ft. high. They are placed on the locomotive boiler behind the dome, and clear of the side view of the driver, as it occupies a centre position on the boiler. Steam is taken from the dome, and exhausts by the chimney. The engine, which develops 10 h. p. and makes a thousand revolutions a minute, weighs only 57 lb.; and the dynamo, engine and bed complete weigh 3½ cwt. The wires and lamps are so arranged as not to prevent oil lamps from being put in at a moment's notice in the event of a train being divided from the main, and run on to a branch line; but the Great Eastern Railway Co. contemplates applying the electric light to the whole of its trains.—*Mechanical World* (Manchester).

It has been decided to light the Imperial Palace, the Court Opera House, and the Burg Theatre of Vienna with electric lights. The palace will be illuminated with 5,000 lights, the Opera House with 4,000, and the Burg Theatre with 3,000. The system to be employed is the Turettini patent.

A central station is being established at Antwerp for the purpose of supplying 6,000 incandescent lamps. The dynamos are of the Gulcher pattern, the current being conveyed by underground cables of the Callender system.

A petition has been presented to the Paris Municipal Council requesting the Administration to study suppression of gas in the schools and colleges, and the adoption of electric light. If this is found impracticable, the petitioner, M. Lyon-Alemand, advises a return to oil lamps.

PERSONAL MENTION.

John Benjamin Page, for many years the manager of the Western Union office at the Metropolitan Hotel, has resigned his position, and returns to Canada to engage in the leather business with his brother at Kingston, Ont.

The King of Portugal has recently conferred the honor of Cavalliero do Christo on Mr. Alan Danvers, engineer and manager to the Edison-Gower-Bell Telephone Company at Lisbon.

William Cassils, an old telegrapher—now a Director of the Montreal Telegraph Co.—is one of the incorporators of "The Herald Newspaper and Printing Company," of Montreal.

Mr. Mackay, of the Mackay-Bennett Cable and Postal Telegraph Company, is a native Canadian, and hails from Cobourg, Ontario.

Joseph E. Fenn has been appointed Electrician of the Southern division of the Western Union Telegraph Company, with headquarters in New York city.

SUBMARINE CABLES.

The Dominion government is being petitioned to lay down a telegraph cable between Amherst Island, Lake Ontario and the mainland.

The annual report of the Anglo-American Cable Co., indicates that a large reduction in the revenues of the cable pool is expected to result from the competition of the Commercial Cable Co.

THE TELEGRAPH.

Domestic.

The reports of the amalgamation of the Postal and Bankers and Merchants' companies are daily growing more definite.

Brooklyn has over 3,000 miles of telegraph wires within her borders, and ten miles of cables, all overhead. The city owns 190 miles of this in fire department wires, and 90 in police department wires.

The Phelps Induction Telegraph Company has filed its certificate of incorporation in this city. Its objects are to manufacture instruments and apparatus to be used in telegraphing to and between railroad cars while in motion.

The Baltimore & Ohio Telegraph Company will make strenuous efforts to obtain equal privileges with the Western Union on the lines of the Pacific railways. These roads having been liberally subsidized by the government, an appeal will be made to Congress, provided a satisfactory arrangement cannot otherwise be made.

The Railway Telegraph and Telephone Co., has been incorporated in New York state. Its object is the application of electricity to communication with moving trains, and similar purposes. Thomas A. Edison, S. Bergmann and Charles Batchelor are among the incorporators.

Under the pressure of the recent increase in the number of fires that has seriously crippled the force, the New York Fire Commissioners have directed the Superintendent of the Telegraph to report a plan for transmitting alarms that will relieve the companies from the necessity of hitching up for alarms from remote sections of the city. The resolution sets forth that under the present system of sending all fire calls to every company in the department the men are often unnecessarily deprived of needed rest.

Foreign.

The expenditure upon Canadian government telegraph lines for 1884 was $127,364. The government lines in operation in the North-west extend 620 miles from Qu'Appelle station to Edmonton, 537 miles, and from Clark's crossing to Prince Albert, 83 miles. Some portions of these lines require repairs and others rebuilding.

THE TELEPHONE.

Domestic.

Annual meetings of the Iowa Union Telephone and the Iowa and Minnesota Telephone companies were held recently at Davenport for the election of officers. The former company's territory covers 50 counties in Iowa, with 1,974 miles of poles and 2,700 miles of wire.

It is said that residents of Lowell, Mass., are represented in the Erie and New England Telephone companies, to the amount of $3,000,000. The Erie company had in use 8,999 telephones Dec. 31, a loss of 154 during the month.

Foreign.

The Bell Telephone Co., of Canada, will endeavor to have the recent adverse decision in the telephone suit set aside. The patents for battery transmitters are not affected by it, and any infringements upon them will be prosecuted.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 59 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From January 27, to February 17, 1885 (inclusive).

Alarms and Signals:—*Indicator for Base-Ball or Cricket*, W. Williams, 311,278, Jan. 27. *Thermostat*, G. R. Williams, 311,933, Feb. 10. *Alarm Mechanism and Apparatus*, W. M. Pease, 312,504.

Clocks:—A. S. Crane, 311,234, Jan. 27. *Apparatus for Synchronizing*, J. A. Lund, 312,482, Feb. 17.

Commutators:—*Cut-out for Apparatus*, S. H. Short, 312,242, Feb. 10.

Dynamo Machines and Motors:—*Dynamo*, F. G. Waterhouse, 311,547, Feb. 3. *Armature for*, F. K. Fitch, 312,111, Feb. 10.

Conductors, Insulators, Supports and Systems:—*Skeleton Tower*, J. S. Adams, 311,165. 311,166, Jan. 27. *Cable*, H. A. Clark, 311,174; W. R. Patterson, 311,521. *Method of Repairing Same*, same, 311,522. *Means for Hanging Same*, same, 311,523. *Circuit Connection*, T. T. Smith, 311,616, Feb. 3. *Circuit Opener*, W. H. Sawyer, 311,681. *Circuit*, W. A. Shaw, 311,682. *Apparatus for Filling Cable Pipes*, W. R. Patterson, 311,913, Feb. 10. *Joint for Arc-lamp Cables*, same, 311,914. *Insulated Conductor*, W. P. Thomas and E. J. Frost, 312,405, Feb. 17. *Wire Splicer*, P. A. O'Malley, 312,580. *Circuit for Systems Electric Lighting*, W. M. Thomas, 312,589.

Galvanic Batteries:—*Porous Cup*, C. P. Orne, 311,516, Feb. 3. *Battery*, A. M. Young, 311,630; I. L. Roberts, 311,853. *Carbon Battery Element*, same, 311,852. *Galvanic Element*, A. Dun, 312,339, Feb. 17. *Apparatus for Charging and Emptying Same*, same, 312,340.

Lamps and Appurtenances:—*Lamp Fixtures*, E. Weston, 311,338, Jan. 27. *Portable Lamp*, T. T. Smith, 311,617, Feb. 3. *Arc-lamp*, B. B. Ward, 311,546; C. F. Brush, 312,184, Feb. 10. *Feed Regulator for*, S. H. Short, 312,243. *Incandescent Lamp*, O. B. Fahnehjelm, 312,452, Feb. 17. *Hanging Balanced Lamp*, T. T. Smith, 312,394. *Cut-out for Lamps*, W. M. Thomas, 312,529. *Apparatus for Treating Incandescent Carbons*, E. A. Colby, 312,552.

Ignition:—*Knob for Gas-Lighting Apparatus*, F. Lane. *System of Firing Turret Guns*, T. R. Timby, 312,231, Feb. 10. *Torpedo*, T. Nordenfelt, 312,579, Feb. 17.

Miscellaneous:—*Device to Assist Hearing*, L. Ehrlich, 311,180, Jan. 27. *Exercising Apparatus*, J. H. Shaw, 311,381. *Demonstrative Electrical Apparatus*, J. D. Culp, 311,725, Feb. 3. *Rheostat*, J. Doyle, 311,820. *Toy Swing*, M. Bacon, 312,178, Feb. 10. *Anti-Magnetic Watch-Case*, C. K. Giles, 312,458, Feb. 17. *Electro-Magnetic Comb*, W. T. McGinnis, 312,487. *Instrument for Electrical Reporting*, W. M. Pease, 312,503. *Electro-Magnet*, E. F. Recordon, 312,511.

Protectors:—*Telegraphic and Telephonic Instrument Protector*, G. A. Cardwell, 311,957, Feb. 10.

Railways and Appliances:—*Automatic Time Signal for Railways*, F. H. Young and F. I. Davis, 311,705, Feb. 3. *Indicator for Switches*, G. Otte, 311,846. *Railway Car Telegraph*, L. J. Phelps, 312,506, Feb. 17. *Railway*, L. Daft, 312,557.

Storage Batteries:—*Method of Preparing Elements*, A. K. Eaton, 311,236, Jan. 27. *Secondary Battery*, S. Phillippart, 311,445, Jan. 27; J. W. Swan, 312,599. Feb. 17.

Telephone Systems and Apparatus:—*Annunciator*, W. A. Childs and F. Shaw, 311,472, Feb. 3. *Connecting Cord*, W. H. Sawyer, 311,611. *Circuit and Apparatus*, L. A. Berthon, 311,944, Feb. 10. *Memorandum Holder for Telephone Boxes*, J. F. Gilliland, 311,977. *Transmitter*, J. H. Guest, 311,979; C. A. Randall, 312,160, 312,161; H. E. Waite, 312,409. *Receiver*, C. A. Randall, 312,162. *Telephone*, 312,365, Feb. 17; 312,366; W. R. Miller, 312,492; T. Wallace, 312,533. *Switch-board*, H. E. Waite, 312,410.

Telegraphs:—*Printing*, J. E. Wright and J. H. Longstreet, 311,218, Jan. 27. *Repeater*, J. Kolzer, 311,330. *Combined Audible Stock Quotation System and Fire Telegraph*, 311,756, Feb. 3. *Audible Quotation System*, same, 311,757.

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NEW YORK, APRIL, 1885.

THE McDONOUGH TELEPHONE CLAIM.

THE first patent of Alexander Graham Bell in which was shown and described an apparatus capable of being used as a speaking telephone was issued on the 7th of March, 1876. Within the next few years a number of applications for patents were made by different persons, who claimed to have invented prior to the date of the patent of Bell, either the generic speaking telephone, or some essential portion of the apparatus necessary for telephonic transmission. On the 26th of March, 1878, interference proceedings were instituted by the Commissioner of Patents to determine the question of priority as between the respective claimants.

For the benefit of those not versed in the technicalities of legal procedure, it may be well to explain that an "interference" is a proceeding in accordance with the patent laws of the United States, which is resorted to by the Commissioner for the purpose of hearing and determining the question of priority of invention between two or more parties claiming the same patentable subject-matter, so that the controlling patent may issue to the party who is legally the first inventor. It may be added that the fact that one or more of the parties has obtained a patent, does not operate to prevent the interference, for although the Commissioner has no power to cancel a patent which has once been granted, yet if he finds one of the subsequent contesting applicants to have been the first inventor, he may grant him a patent also, and thus give him a standing which will enable him to prosecute infringers in the Federal Courts.

Subsequent to the original declaration of interference, other parties appeared and were included in it. Owing to the great number of contestants, 14 in all, the taking of the testimony occupied a great length of time, and it was not until the 21st of July, 1883, more than five years after the original declaration, that a decision was rendered by Mr. Church, the Examiner of Interferences, in which priority in respect to most of the essential features of the invention was awarded to Bell, thus confirming his patent against the claims of the various contestants. The most important exception to the general tenor of the decision, was in respect to the electro-magnetic diaphragm receiver, which as is well known forms an almost indispensable part of the practical telephone. On this point, priority of invention was awarded by the examiner to J. W. McDonough, whose application was filed on the 10th of April, 1876, but a short time after the grant of Bell's patent, and before the invention had attracted any particular attention, even among electricians. The decision of the Examiner of Interferences, was appealed to the Board of Examiners-in-Chief, and this tribunal reversed the decision of the Examiner of Interferences, as to the receiver and awarded priority to Bell. The final appeal to the Commissioner was then taken, who has recently rendered his decision sustaining the view taken by the Board.

The award of priority by the Examiner of Interferences to McDonough in respect to the invention of the telephone receiver, has given rise to a wide-spread curiosity to know something of the history of his invention, and we have, therefore, in another place reproduced an article recently published by Professor E. J. Houston of Philadelphia in which the claims of McDonough and the history of his invention are concisely set forth and illustrated with facsimiles of his sketches and drawings of his apparatus. It is proper, however, for us to say that we do not coincide with Professor Houston in many of his opinions, either in respect to the speaking telephone in general, or to the pretensions of McDonough in particular, whose work at best can fairly be said to be little more than a crude experimental reproduction of the well-known apparatus of Philipp Reis. His transmitter was essentially that of Reis; his receiver was a parchment membrane stretched over a ring or hoop, and having an armature fixed upon it in proximity to the poles of an electro-magnet. There is perhaps no reason to doubt the general truth of the statement of the witnesses in behalf of McDonough as to his experiments in June, 1875. This testimony goes to prove that tunes were recognized, together with some words of the tunes, but it is familiar to those accustomed to experimenting with telephones, that a sound resembling that of a well-known tune irresistibly suggests to the mind the accompanying words, a mental deception which it is extremely difficult to avoid. The apparatus shown in McDonough's application for a patent is substantially a Reis transmitter placed in circuit with the diaphragm receiver above mentioned. Professor Houston says that "there appears to be ample testimony by the most able experts that apparatus constructed in accordance with McDonough's specification of April 10, 1876, can and does clearly transmit intelligible articulate speech."

At this point, we decidedly take issue with Professor Houston. We think it not improbable that a few words and perhaps even sentences may have been successfully transmitted by means of a McDonough transmitter and a magneto-receiver, that is to say a receiver having an electro-magnet with a permanently magnetized core. But without such a receiver, it is probably quite safe to say that an intelligible sentence has never been received, even by an "expert," from the transmitter described in

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McDonough's specification. But McDonough neither invented nor described the diaphragm receiver with a magnetized core, in other words, the true magneto-receiver. This was first made and publicly exhibited in this country by Gray in July, 1874, and in England in August of the same year. In a somewhat different form it is shown and described in Bell's patent of March 7, 1876, and the credit of the discovery is due either to Gray or Bell, certainly not to McDonough. Hence even if it were true, as Professor Houston suggests, that the real improvement which converted the apparatus of Reis into a commercially valuable organization consisted merely in the invention of a more suitable receiver, it was not McDonough who put the finishing touch to the invention. Professor Houston speaks of the "generally acknowledged fact that the Reis transmitters operate very satisfactorily when combined with magnetic diaphragm receivers" as if there were no question about it. We think that the spectacle of an average citizen trying to order his Sunday dinner from the market-man by means of a Reis transmitter and a "magnetic diaphragm receiver" would tend to give a new meaning to the word "satisfactorily." Moreover, if we take the transmitter in any of the different forms in which it was constructed by Reis, without the aid of the additional inventions employed in connection with the modern magnetic receiver, it would be utterly impossible to converse through the apparatus with sufficient certainty to render it of any practical use, in a circuit more than a few feet in length. In order to do this we must add to the microphone transmitter—or Reis transmitter as Professor Houston would probably prefer to call it—an induction coil, otherwise we cannot transmit intelligible sounds through ordinary distances.

The opinion of Commissioner Butterworth, which is final so far as the Patent Office is concerned, is given in full in another column. He decides in favor of Bell, on the well established principle that to defeat a patent already granted, the claimant for priority must prove a prior completed invention, which McDonough in his judgment, has failed to do. We do not see how he well could have decided otherwise, for the issue calls for a receiver "whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality," and it certainly does not appear from the testimony that, prior to the date of Bell's patent, the fact was ever experimentally established by McDonough, that his receiver would reproduce "quality" of sound.

It is probable that the matter will not be allowed to rest with this decision, but will ultimately make its appearance in some form in the Federal Courts.

THE VICISSITUDES OF INVENTION.

At the incipient stage of the electric light "boom" a large investor in gas stocks, panic stricken by the sudden decline in those securities, sought advice as to whether he should hold on or let go. With considerable anxiety he solicited the views of a friend, who was more experienced in electrical matters than himself, who said: "I don't know whether it is a fact, that the anticipated competition of the electric light has depressed gas stocks, but if you are sure of that point, and have plenty of money to invest, I should say buy all you can get hold of at panic prices."

There is a field for the electric light, but it has not, nor will not drive out gas; neither will gas supersede petroleum nor oil lamps render the candle obsolete. Although the candle still figures in parlor entertainments as "the light of other days," the gross amount of its manufacture increases yearly. Public opinion is not a reliable prophet. It was predicted that the advent of the railway would make horses a drug in the market. It was not supposed that railways could successfully compete with steamboats. After fighting rapid transit for years in New York city, the horse railway companies have discovered that their profits are larger than they were before the elevated railways were established. It was confidently asserted, even by men who ought to have known better, that the telephone would inevitably supersede the telegraph, and we presume that at this moment certain inventors are toiling hopefully in the belief that the telephone will be adopted for the Atlantic cables, as soon as they can practically demonstrate the feasibility of oral communication through them. Telegraphic history is replete with the curiosities of electrical development. Under the assumption that the dot-and-line characters could not possibly be made with reasonable accuracy by hand, metal type were originally designed for the purpose of manipulating the circuit-breaker automatically. The operator who read "communications" from the paper tape, was allowed a copyist to facilitate his work. After this assistant had been finally dispensed with as a matter of economy, the operator eventually discovered that in spite of the prohibitory orders of the management he could read by sound and copy, more easily and rapidly than he could follow the characters embossed on the tape. With the advent of the House printing instrument, the Morse system was thought to be certainly doomed to early extinction. Anybody could learn to telegraph on a plainly lettered key-board, while the satisfaction of receiving a message, plainly printed, in Roman letters would lead the public to give their entire patronage to the printing lines, which assumed to be "prompt, accurate and reliable." To-day the printed telegram is declared a nuisance in the counting-house, because by reason of its peculiar form it is awkward to file away, while under the derisive appellation of "snake copy" it is heartily detested by every newspaper compositor. Various automatic and chemical devices have had their rise and fall; some have had their advantages, and more their defects, but as a universal and comprehensive system the old fashioned Morse stands to-day practically impregnable. It is the general tendency of improvement to render any device more simple, and automatic; that is, less dependent upon the supervision and immediate attention of man. It is for this reason that we have looked upon the arc-lamp as a comparatively crude device. It must each day be supplied with new points, and consequently receive the personal attention of a "trimmer," armed with a step-ladder and a haversack filled with carbon pencils. It is true that it fulfills its mission, and so did the old hand-brake on railway trains, although every intelligent man knew that the time would come, when a satisfactory power brake would be introduced, under the direct control of the engineer. The balloon affords the means of traveling in

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the air, yet it is by no means a solution of the ideal problem of aerial navigation. It is rarely that a thoroughly complete invention becomes obsolete. The sailing vessel still holds its own, although its field is becoming narrowed; the Indian canoe of the north-west coast is still the model of the fastest sailing craft. One can recall scores of inventions such as the snow-shoe and the Chinese gong upon which no improvements have been affected within the memory of man, while others perhaps equally meritorious are entombed among the "lost arts."

DEATH IN THE AIR.

In their anxiety to harass existing electrical companies, by forcing them to place their wires underground, other and more serious overhead dangers have escaped the attention of the public press and our legislators.

During the high wind which prevailed in this city and vicinity on February 17th, the following casualties occurred, according to the news columns of the *New York Times:*

Caroline Carlton, of No. 1,450 First avenue, was struck on the shoulder and severely injured by a sign which was blown from No. 400 Third avenue.

William Hawe, of No. 602 West Thirty-seventh street, while passing Thirty-third street and First avenue, was struck with a plank blown from an unfinished building, receiving concussion of the brain.

Sarah Waters, a child, whose parents live in East Twenty-second street, was struck on the head and seriously injured by a sign blown from a liquor store at First avenue and Twenty-sixth street.

Barbara Kaufman, 50 years old, while passing No. 158 Crosby street, was struck on the head by a sign belonging to Lippincott & Co., and was severely injured.

An iron shutter weighing about 150 pounds was blown from its fastenings at one of the upper windows of the tall Mortimer Building, in Wall street, about noon, and it cut a small hole in the iron roof of the Stock Exchange. The noise that the shutter made in falling caused something of a scare in the Exchange.

It appears strange that a journal which has been so active in the instigation of public prejudice against aerial wires, should wholly ignore the far more imminent danger arising from the thousands of signs hung at various heights and positions, often insecurely fastened, and subject neither to official inspection, or any legal restriction which in any manner exacts responsibility from the mechanic who paints and erects them. This lax state of affairs is the more reprehensible for the reason that these signs do not in the slightest degree serve any useful purpose in behalf of the people whose lives are continually threatened by their existence. Neither are they a necessity to their owners. Some of the most important business houses in every city, are devoid of obtrusive signs. The Western Union Telegraph Company denotes its principal office by a modest sign not ten feet from the ground, which a cyclone could not remove. The great business of A. T. Stewart and Company was maintained in its prosperity without a sign of any description on the buildings. Certainly it cannot be necessary for a great newspaper like the *New York Times* to placard its building with large signs in order to assure the public that it continues business at the old stand, and that thankful for past favors it respectfully solicits a continuance of the same. Owners of the finest buildings now erected for rental in New York city, prohibit the display of signs other than the regulation directory upon a panel at the entrance, where each tenant is placed upon an equal footing with the other occupants of the building, and required to have his name inscribed in letters of a specified and uniform size.

We believe the mercantile community would experience a feeling of relief if a general law was passed compelling every firm and individual, to either dispense with signs altogether, or force all of them to adopt a uniform standard to conform for example with the letters used for designating the names of streets on the city lamp-posts. We respectfully call the attention of Senator Daly to the consideration of this question.

WHERE ARE THE ELECTRIC MOTORS?

The electricians, or capitalists and patentees interested in electric motors, who have been for months asserting that electrical transmission of power could be economically applied to the moving of railroad trains, are tiresomely slow in reducing their schemes to practice. Months ago we were told, and the assertion was industriously repeated by the daily press, that Mr. Daft was making preparations to lay electric conductors on the Brooklyn bridge, by which he would at once demonstrate how cheaply and promptly the cars would be moved by electricity. That scheme was suddenly abandoned, without any cause given, and we were then told that Mr. Daft was going to experiment with electric motors on the Ninth avenue elevated railroad. Mr. Daft was wise in his generation in abandoning the Brooklyn bridge, where heavy tractive power is needed, and the exact power used to move cars by cable can easily be ascertained. He has now got official permission to lay down a conducting rail on the Ninth avenue road, but week after week passes and nothing is being done to forward the work. Mr. Field's company has got permission to lay a rail on the Second avenue road, and they also do nothing further in the matter. Come along with your electric motors, gentlemen, the public is waiting for them, and you have roused expectations that ought to be allayed.—*American Machinist.*

Four months have elapsed since President Cyrus W. Field of the Manhattan Elevated Railway, in his annual report suggested the use of electrical motors upon the roads operated by that company. Subsequently the directors formally authorized the executive officers to allow the Second avenue line to be used for experimental purposes. Possibly the editor of the *American Machinist* may have had practical experience in the actual manufacture of machinery, if so he should know that very few, if any establishments exist, where experimental apparatus of this character constructed from new designs, can be completed in three months. In order to relieve his apparent anxiety however, we are authorized to state that a special car built by the Pullman company to be fitted with motors, will be delivered within a month. The necessary quantity of 70-lb. steel rails have been ordered for the central conductor, and the money is ready to pay for them. Whether or not electrical motors will be adopted for service on the elevated railway we are not prepared to say, but the prospects now are that the editor of our esteemed contemporary may avail himself of an excursion on the fourth of July, in a car driven by the agency of electricity on the Second avenue line.

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ARTICLES.

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 89.)

IRON POLES.

WHILE the use of iron for this purpose is by no means extensive, it is constantly increasing in favor, and will probably become very common in countries where wood is scarce, or where it rapidly decays. Its use is to be commended, even in this country, for lines which pass through parks or private grounds, or through handsome streets where the ordinary wooden pole would be objected to by municipal authorities or property owners, as it is capable of being constructed in many ornamental and symmetrical forms. Of course the cost of an iron pole is much greater, but as a general thing it is more economical in the end to pay a little extra in this way, than to offend the sensibilities of the abutters. If poles formed completely of iron cannot conveniently be procured, a compromise may sometimes be made, by planting a stout cast iron socket, placing therein a strong shaft of timber, to give the desired length, and surmounting this shaft again by an iron top piece, carrying the iron cross-arms. The top piece cross-arms, and insulator pins may be made of gas pipe ; or the cross-arms may simply be short iron bars bolted to the pole, to which may be attached either pins or brackets.

Railroad officials or amateurs connected with railroads, will find that old rails make very good poles, as does also gas pipe ; the latter especially when but a single line is required. Several forms of iron poles are already in use in foreign countries : In Switzerland for example, an iron pole consisting of a conical wrought iron tube is used ; its length varies from 11 to 8½ feet, its diameter at the base is about 2¾ inches, and at the small end about 1½ inches. These poles are set in foundation blocks of stone, the size of which depends on the size of pole which it is to support.

The iron post of W. Siemens is perhaps more extensively used than any other. It is formed in fishing-rod style of two tubes telescoping into one another, the upper one being usually surmounted by a lightning discharging point, while the lower end is secured by four bolts to a buckled iron plate bent or pressed into a dish-shaped form by which great strength is given to it. For a line of not more than three or four wires they form a very elegant support, and are made in sizes varying from 20 to 24 feet long, the average weight being about 185 pounds.

Lieut. James A. Swift in his book "The Practical Telegrapher" describes a very simple iron pole used by the U. S. Signal Service for single wire coast lines. It is of good iron, 20 feet long in the full ; is tubular, having an external diameter of 2¼ inches, and weighs without the attachments about 75 pounds. The pin carrying the insulator is round like an ordinary cross-arm pin, and is fitted in the top of the pole. The most ingenious thing about the pole to my mind, is the arrangement provided for climbing. A hole is made through the tube from side to side about four feet from the top, and in this hole an iron bar about 15 inches long and five-eighths of an inch thick is thrust. A narrow strip of wood some 10 feet long and two by four inches thick, has spikes driven into its sides as steps or foot irons, while two hooks at its upper end are adapted to hang on the cross-bar above. The lower end is prevented from swinging round, by a clamp which clasps the pole. This arrangement being light is easily carried round from pole to pole.

It may be stated here, before we part company with the subject of iron poles that they have an advantage over wooden ones, in that being metal they themselves serve as lightning and leakage conductors ; while they also have a corresponding disadvantage, in that a wire accidentally slackened or freed from the insulator, and hanging loose, will almost certainly fall against the pole and thus form a dead ground, while with a wooden support, in fine weather, the line could be readily worked as well as before.

CROSS-ARMS AND BRACKETS.

If only one wire is to be carried, one of two attachments may be adopted.

The insulator may be fixed to a bracket, and the bracket spiked to the side of the pole a few inches below the top ; or the insulator may be affixed to a pin which is driven in a hole at the top of the pole. When the latter mode is adopted, an iron ring smaller when cold than the top of the pole, should be heated to bright redness and then slipped over the small end to prevent it from splitting. The bracket plan is however preferable, as the insulator and pin when attached to the top of the pole, are apt to be lifted off, when the pole is planted in a hollow, and even on a level there is an upward tendency. Brackets are made of locust or oak, should be painted before attaching to the pole, and are spiked to the poles.

It is better if more than one wire is to be strung, to use cross-arms. These are best made of white pine—and are of four by five stock. They are planed and have their upper corners beveled. The length of a standard cross-arm for two wires is three feet ; for four wires five feet six inches ; and for six wires seven feet six inches. It is usual to make the distance between the insulators 22 inches from centre to centre ; and more than six wires are rarely placed on one cross-arm. The sizes given are for regular telegraph work. For telephone lines the insulators are usually placed nearer together, and as many as 10 or 12 on the same arm.

A thing not always attended to in the United States, is the numbering of poles and wires. Every line of a mile in length, or over, should have its poles numbered and a record of such numbers ought to be kept by a suitable officer. The work of maintenance is thus made much easier, for the location of any trouble can be more clearly indicated. Each wire should also be numbered, and the system of numbering pins should be uniform, so that the bare mention of a pin by its number may at once indicate to the mind's eye its exact position.

Before attaching the cross-arms to the poles, spaces are cut for their reception—these spaces are technically called "*gains.*"

They are cut of sufficient width to give a snug fit to the side of the cross-arm and may be nearly two inches deep from the front of the pole. Brackets and cross-arms should always if possible, be attached before the pole is set ; and may be fastened with bolts and nuts, with or without the addition of lag screws or spikes. All screws, spikes or bolts used for this purpose *should be greased before they are used, to prevent rust.* Cross-arms should also be well painted before being attached to the pole.

It is a saving of both time and work to fit the cross-arm with its pins, and to screw on the insulators, before the pole is set up, yet the insulator should not be screwed down tight, but merely attached loosely; so that it can be screwed down when the wire is strung.

HOUSETOP LINES.

It should be a rule of the line constructor, never to run a housetop line if pole rights can be procured. A line run over housetops is absolutely at the mercy of the householder ; is liable to be cut at any time ; is by no means so strong as a pole line, and at any time an order to remove the fixtures may be expected.

Many telephone companies which built expensive housetop systems of lines when beginning business, have been compelled to completely rebuild, after paying immense sums as damages for alleged roof injuries, and poles are in all cases to be preferred. Yet housetop construction, to a

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greater or less degree, will probably be carried on for some years yet, and an article on construction would manifestly be incomplete without reference to it.

The fixtures employed to support roof lines, are of several kinds—but may, perhaps, be broadly divided into the two great classes, *i.e.*, wall and roof fixtures. Both classes, again, may be either double or single, according to the number of wires which are to be supported. Roof fixtures are those which are placed with their foot on the roof—they are fastened to the roof by iron angle plates, which are fixed by screws, and are furthermore firmly braced by iron rods, in the direction of the wires on both sides.

Wall fixtures are spiked to a piece of plank about five feet long, 10 inches wide and two thick; the said plank being first spiked to the wall itself with seven inch spikes. These uprights are, or should be, five inches square and 20 feet long, 15 feet of which are elevated above the wall, the remaining five stretching over the baseplank. Such an upright may reasonably carry three cross-arms; the bottom one being 54 inches long; the middle one 33 inches, and the top one 18 inches long. The same thickness of upright may be used for double fixtures, but the cross-arms for these are, of course, extended across and supported by both uprights, which are braced together by wooden

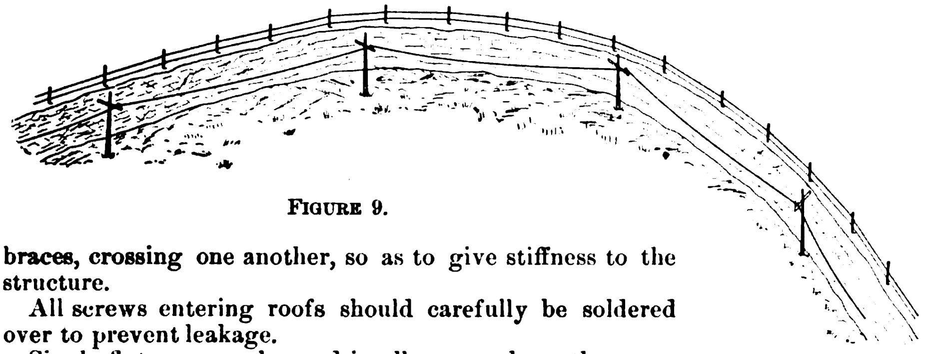

FIGURE 9.

braces, crossing one another, so as to give stiffness to the structure.

All screws entering roofs should carefully be soldered over to prevent leakage.

Single fixtures may be used in all cases where there are not more than a dozen wires. All housetop fixtures, cross-arms and boards ought to be of white pine, painted. In addition to these fixtures, some constructors use tripods, composed of three round iron rods welded together at the top, which is made to serve as the insulator pin. The use of these contrivances is not to be commended, unless they are made very high, inasmuch as wires run on them when low are apt to trip the unwary lineman precipitately into the street. Ridgepole irons and chimney irons are also sometimes used, and serve very well for the attachment of glass insulators, but on the whole, a wooden block, with a rubber-hook insulator is preferable for such work, especially if the wire is a light one, because in lieu of using a tie wire, the wire can be twisted round the hook, while where the block cannot be conveniently placed, a batten or counter-brace consisting of a three by four, or four by five-inch pine stick, spiked to the roof at one end, and projecting over, may be used. Without exception, housetop fixtures must be guyed against lateral strain.

Where a heavy line runs straight from fixture to fixture, it requires two guys to the fixture, one on each side, to stay it against the side pressure of the wind. When a line makes an angle with a fixture, the guy must be so arranged as to pull against the angular strain. Where the span on one side of a fixture is longer than that on the other, a guy is required on the short side to balance the surplus strain. It is customary to use No. 9 B. W. G. wire for housetop guys, although a pair of No. 12 wires will do quite as well.

ACTUAL CONSTRUCTION.

When a line, short or long, is to be built, unless the person in charge of the construction well knows the two terminal points, and all available routes between them, the road should be carefully gone over, and a route laid out, before any work is done, and if any rights of way are necessary, they should be arranged, so that when the construction gang comes along, it will have nothing to do but its own work. If it is a long line, and the men have to rest in a different place every night, suitable places should be agreed for, where they may board in as comfortable a manner as possible.

The person who goes over the road, if a capable and practical constructor himself, can render material assistance to those that follow after, besides aiding to soften the acerbities which sometimes spring up between the pole owners and the pole abutters, when passing through towns and villages. A line of wire has, of course, more or less, to follow the windings of the road, but in many places there is waste land, likely to remain so for years, and such places, when treeless, may be availed of to shorten the curves. Some suitable mark to designate where poles are to be planted is to be adopted, and while it is never well to be chary of poles where it is needful to set them pretty close together, it must not be forgotten that while multiplying the number of poles in a given distance does assuredly give greater mechanical permanence and stability to the line, it at the same depreciates the insulation by multiplying the possible points of leakage. Here, therefore, is a great chance for good judgment, and a good line is one in which the happy mean is taken.

It may be thought immaterial which side of the road is taken, but as a matter of fact this needs as much care as any part of the business. There are many points which may guide one in this matter, and frequently the conditions leave one without any alternative. The amount of adjoining waste land on either side, or the number of trees or houses, all aid in determining this question. All things being equal, however, on a curved road, it is far better to set the poles round the inside of the curve; and this for two reasons—in the first place the line is thus shortened; and in the second place—as may be seen by the diagram, figure 9, the line is thus arranged with the strain off the road, so that if the wire in any way becomes freed from one or more of the poles, it tends to swing away from, instead of over the road.

(*To be continued.*)

MEASURING THE VELOCITY OF PROJECTILES.[1]

BY HENRY A. SINCLAIR.

(Electrician U. S. Ordnance Proving Ground, Sandy Hook, N. J.)

I PROPOSE this evening to describe some of the instruments used for ascertaining the velocity of projectiles; but before doing so it might be well to state why it is desirable to know this velocity.

It is a means of comparing the powers of guns, of comparing different kinds of powders and projectiles, of determining their energy, and approximately their range and penetration into iron plates. When a new gun, a new kind of powder, or a new projectile is made, the question is not how far will it shoot; but what is its velocity and energy.

Very few persons realize how much energy a large projectile possesses. A 12-inch shot of 700 pounds, moving with a velocity of 1,500 feet per second, will have as much energy as a railroad train, consisting of a locomotive and five or six cars (weighing about 100 tons), moving at the

1. Read before the *New York Electrical Society*, February 25th, 1885.

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rate of 57 miles per hour. The formula for energy being $E = \frac{W V^2}{2 g}$ in which W=weight, V= velocity, and g = force of gravity = 32.1651, we have for the projectile $\frac{700 \times 1500^2}{2 \times 32.1651 \times 2240} = 10,860 +$ foot tons. For the railroad train we have (100 tons = 224,000 pounds, 57 miles per hour = 83.6 feet per second) $E = \frac{224,000 \times 83.6^2}{2 \times 32.1651 \times 2,240}$ = 10,860 foot tons.

It thus being important to know the velocity, I will endeavor to show how it is determined, first mentioning some of the early attempts in this direction.

Robbins, as early as 1740, used the "ballistic pendulum," which consisted of a pendulum suspended from a tripod, the bob being so arranged as to receive the impact of the projectile, a prolongation of the pendulum below the bob registering its degree of vibration. In 1781, Count Rumford reported results of experiments made with the "gun pendulum," using a gun suspended in a horizontal position and free to vibrate. The arc of the recoil being accurately measured when the gun was fired. Extended experiments were made with this apparatus in this country between 1843 and 1848. Professor Wheatstone, in 1840, first suggested the use of electricity, which was tried as follows: Two targets of wire, so placed as to be cut by the projectile in flight, formed each a part of a circuit containing an electro-magnet. These magnets held each a pencil over a cylinder revolving uniformly, and as the targets were broken the pencils were released, dropped upon, and marked the cylinder. The speed of the cylinder being known, the distance between the two marks determined the time of the projectile's passage between the targets.

It will be seen that the use of electricity depends upon its great velocity which may be considered instantaneous for short distances, the difficulty being to register the exact instant the projectile ruptures the target wires.

Professor Henry, in 1843, proposed using the spark from an induction coil. This has since been used on some of the finest instruments. In 1849, Captain Navez used an instrument operated by an electro-magnet arresting the motion of a moving index. In 1854, Captain Siemens, of the Prussian service, used sparks from a Leyden jar.

Vignotti, in 1858, invented an instrument which consisted of a graduated arc holding a chemically prepared paper; a pendulum vibrating freely; and two induction coils, whose primary circuits were connected with the targets, and the secondary circuits connected in series, one pole to the pendulum, the other to the arc. An electro-magnet having in circuit a wire across the muzzle of the gun held the pendulum at its initial point and released it when the wire was broken. On breaking each target wire, a spark passed from the now falling pendulum to the arc, leaving impressions on the prepared paper. From the location of these impressions, the time of the projectile's passage between the targets was easily found and consequently its initial velocity. This instrument, with some modifications, was in use as late as 1876. Col. Benton's machine, invented in 1859, had two pendulums, their axes being in the same line, swinging freely in front of a graduated arc. Two electro-magnets so placed as to hold the pendulums in a horizontal position at opposite ends of the arc, are in the target circuits. The pendulums being released upon the breaking of the target wires mark the arc when passing each other, the position of this mark denoting the time of the projectile's flight. This machine is still occasionally used in this country.

Captain Schultz, of the French artillery, has devised an instrument by means of which intervals of time from 30 seconds to the $\frac{1}{5000}$ part of a second can be readily measured and even these may be subdivided. It consists essentially of a cylinder, an induction coil, a vibrating or tuning fork, electro-magnets, and a conjunctor. The cylinder, A, figure 1, is driven by a system of clock-work, operated by a weight, giving to it a double motion of rotation and translation, its bright surface (usually silver plated) being covered with a thin coating of lamp-black. At D is an induction coil, whose primary circuit is connected to the targets as follows: From one pole, E, wires lead to both the first and second targets, from the other pole, F, the

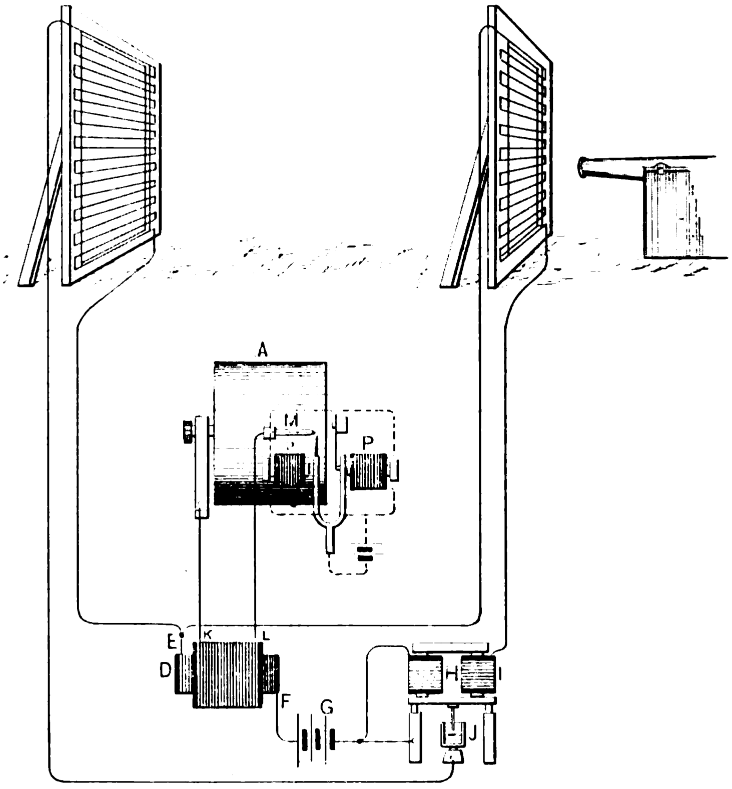

FIGURE 1.

circuit passes through the battery G, and the electro-magnet H, of the conjunctor I, to the other side of the first target. This electro-magnet holds an armature, carrying two metal rods, sliding in upright cylinders, also a small pin, the lower end being just above the surface of mercury contained in the cup J.

At the breaking of the first target wire, this armature is released completing the circuit through the mercury to the second target before the projectile reaches it. In the secondary coil, one pole, K, is connected to the frame work supporting the cylinder, and the other pole, L, passing through an insulating glass tube, M, terminates close to the surface of the cylinder, so that on the breaking of each target circuit a spark passes from the end of the wire to the cylinder, leaving a slight trace on its blackened surface.

Firmly secured to the bed plate of the instrument is a vibrating fork, the left prong of which carries a small quill which can be made to touch the cylinder at pleasure. On either side of the fork are electro-magnets, P P, which serve to originate and sustain its vibrations. From one pole of the battery the current enters at the bottom of the fork, passes up the right prong, and out at a light spring which just touches it, where it separates, half passing through each electro-magnet, and then, reuniting, passes to the other pole of the battery. When the circuit is closed the prongs are drawn apart by the magnets and the circuit at the spring is broken, the prongs being released return and close the circuit and again the magnets draw them apart. The fork is thus kept in constant vibration similarly to the fork in the Gray harmonic telegraph system. The quill on the other prong traces its vibrations on the blackened surface of the revolving cylinder. These vibrations are known to be isochronal for the same fork

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when their amplitude is constant, that is, the fork makes the same number of to-and-fro motions in a second; thus giving a scale of time. On the breaking of each target circuit, the sparks fall in between or close to the line traced by the fork. We have then only to count the number of vibrations between the two sparks for the time.

The fork in use at Sandy Hook makes 250 double vibrations per second, consequently one vibration represents $\frac{1}{250}$ of a second. Suppose, for example, that the number of vibrations between the sparks is $16\frac{1}{4}$, the time will be $16\frac{1}{4} \div 250 = 0.065$ second and with a distance between targets of 100 feet, the velocity equals $100 \div 0.065 = 1423$ feet per second, or with the distance between the targets of 10 feet and the number of vibrations between the sparks 1.3, the velocity will be $10 \div \frac{1.3}{250} = 1993$ feet per second. When the cylinder is moving rapidly one vibration ($\frac{1}{250}$ of a second) covers about one inch space on its surface, this can be readily divided into 20 parts which would give $\frac{1}{5000}$ of a second, and by means of a micrometer even this is subdivided so as to read $\frac{1}{500000}$ of a second of time.

It will be seen that the speed of the cylinder does not

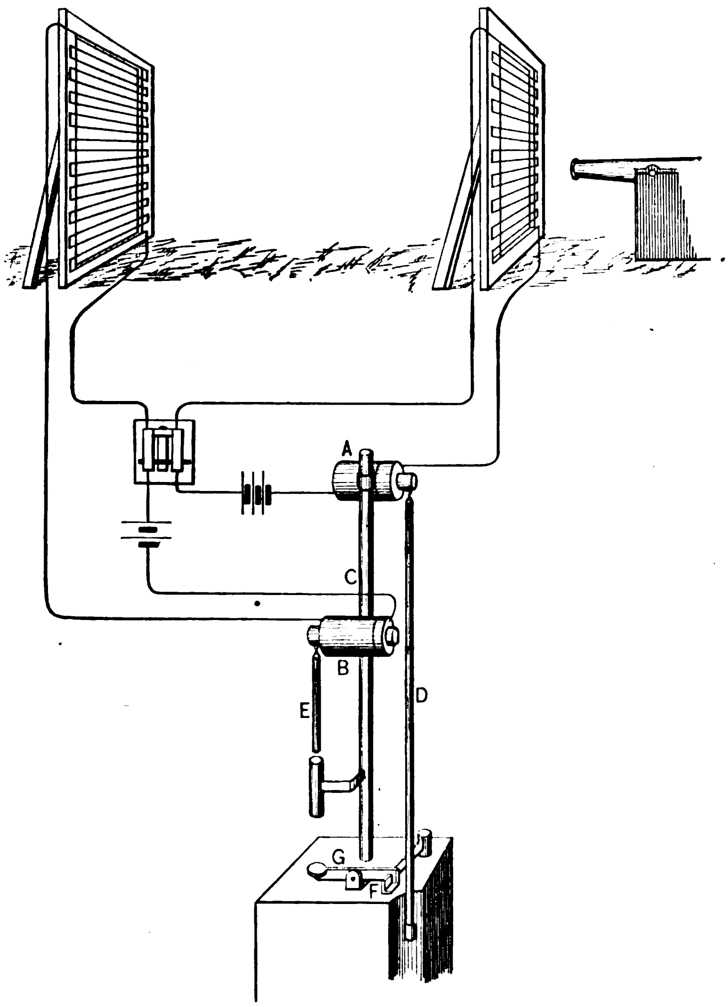

FIGURE 2.

affect the time—all that is necessary is that it should be uniform for one vibration. The targets are sometimes arranged with springs, so that the velocity is taken at 5 or 6 points or even more, the current being thrown from one target to the other in rapid succession.

The instrument now generally used both in this country and Europe is the "Boulengé chronograph," which for simplicity and ease of working is unexcelled. This instrument, figure 2, has two electro-magnets, A B, supported by the upright pillar, C. The upper magnet, A, is in the first target circuit, and suspends the long rod, D. The lower magnet, B, is in the second target circuit and holds the short rod, E. These rods are released on the breaking of their respective target circuits, the long rod falling in front of the circular cutter, F, secured to a stiff spring which is retained by the trigger or catch, G. The short rod being released at the breaking of the second target wires strikes the trigger and frees the cutter which darts out, making a small mark on the long rod as it is passing.

The height of this mark shows the distance the rod has fallen while the projectile is passing between the targets. The time is then calculated from the law of falling bodies $T=\sqrt{\frac{2H}{g}}$. It will be seen that there is a short interval of time lost while the rod E is falling and the long one is being marked. The amount of it is ascertained by breaking both wires at the same instant by means of a disjunctor shown at the left, when upon deducting this period from the total time, we have the *true time* of the projectile's flight.

Suppose the height of the mark made by the cutter on the long rod, by the breaking of both circuits at the same instant, with the disjunctor, is 0.36024 feet above the zero point, the time of fall will be $\sqrt{\frac{2\times0.36024}{32.1651}} = 0.149664$ of a second; and that the height obtained on the breaking of the target wires is 0.49410 feet, the total time of fall will be $\sqrt{\frac{2\times0.49410}{32.1651}} = 0.175279$ of a second, then we will have as the actual time of the projectile's flight $0.175279 - 0.149664 = 0.025615$ of a second, and taking the distance between the targets as four feet, the velocity will be $\frac{4}{0.025615} = 156$ feet per second; or supposing the disjunctor time is 0.150073 of a second and the total time of fall 0.169422, the velocity will be $\frac{4}{0.169422 - 0.150073} = 207$ feet per second.[2]

At Sandy Hook two instruments are used on independent circuits. The distance between the targets being 100 feet; the velocities are usually from three to six feet apart, though often the same.

The following results are taken from the records of the two instruments in use at that place:

Boulengé No. 17.	Boulengé No. 109.
645	644
959	956
1210	1206
1514	1514
1735	1735
1951	1953
2138	2132

The following are taken from the records of the Schultz and Boulengé at Watertown arsenal:

Schultz.	Boulengé.
1267	1271
1277	1275
1258	1258
1224	1225
1182	1182
1235	1240

These tables represent two velocities taken at each shot. The first, where two Boulengés were used, the second, a Boulengé and Schultz.

Mr. F. W. Cushing has lately invented an instrument which he describes as follows:

"A tuning fork is kept in vibration by means of electro-magnets and made to record each vibration upon chemically prepared paper. Across the contact points of the reed is thrown a shunt wire connected through the first 'frame,' while the main circuit passes through the second frame. On the projectile breaking the wire in first frame the vibrations of the reed begin to record themselves upon the paper and continue to do so until the projectile passes through the second frame, breaking the wire circuit. The time of

2. The above results were obtained in an experiment made at the meeting, using a 45-calibre revolver with a charge of 3—3½ grains powder, and a ball weighing 130 grains.

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flight is ascertained by counting the dots upon the paper which indicate the number of fractions of a second that have been used up between the two breaks."

This is now being investigated by a government commission at Philadelphia.

In describing the instruments used for ascertaining the velocity of projectiles, I have not attempted to include all that are used for this purpose, but simply most of those that have been used and are now in general use in this country. It can be safely said that the "Boulengé chronograph" is steadily supplanting all others for ordinary use, where the necessary distance between targets can be obtained; and that instruments of the Schultz class are only used where it is desired to measure the velocity over very short distances, such as the gradually increasing velocity of a projectile along the bore of a gun.

An instrument employed in connection with the velocity instruments, is the "pressure gauge;" its object being to register the pressure in the bore at the time the gun is fired. It is shown in figure 3. In the steel housing, A, is a piston, B,

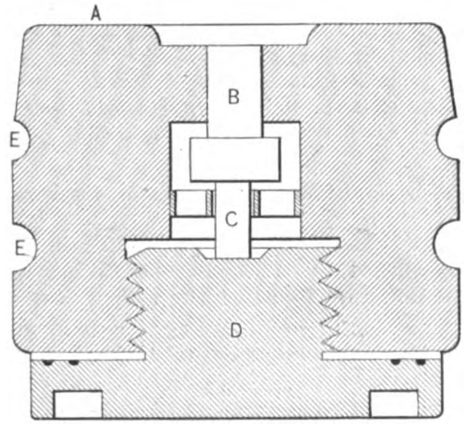

FIGURE 3.

resting on top of a small copper cylinder, C. The housing, A, has a screw plug, D, at the bottom, to admit the placing and removing of the copper cylinder as well as to form a base for it. The whole is tied to the bottom of the bag containing the powder and placed in the gun. On the firing of the gun the pressure of the powder gases forces the piston down, crushing the copper cylinder; the amount it is crushed depending upon the degree of pressure exerted. The length of the copper is then measured and the pressure required to reduce a similar copper to the same length is determined by a weighing machine. The area of the piston, B, being known, the pressure per square inch is easily found. An ordinary pressure for large cannon is from 25,000 to 35,000 pounds per square inch; but it often exceeds this, pressures having been recorded as high as 100,000 pounds per square inch.

By these instruments, the velocity instrument to determine the velocity, and the pressure gauge the pressure, we are enabled to ascertain what powder will give the maximum velocity and power with a minimum strain on the gun. Had this science been sufficiently advanced during the early part of the war, the commander of the Monitor could have used 30 or 40 pounds of powder instead of 15, and easily have sent his projectiles through the iron sides of the Merrimac.

ELECTRICAL MOTORS AND THEIR CONSTRUCTION.[1]

BY JOHN E. CHASTER.

(Continued from page 47).

THE machine is now ready for winding with wire. It must first be taken apart, and in doing this it is advisable to carefully number or otherwise mark the parts that fit together, so that no mistake may occur when the whole is finally put together. The portion of the field magnets with which the coils would otherwise touch must be carefully covered with cotton cloth or canvas, which must be well coated with shellac or Brunswick black varnish. In order to thoroughly insulate the wire from the body of the magnets, the field magnets are to be wrapped with six or seven layers of No. 18 (Birmingham gauge) double cotton covered wire. The proper amount of wire on the field magnets will be determined by there being just sufficient room for the armature to revolve when bolted up. About 1¼ pounds of wire will be ample for the field magnets, and seven or eight ounces of No. 22 (Birmingham gauge) double cotton covered for the armature. In winding the wire it is advisable to employ a Leclanché or other convenient battery, and a small detecting galvanometer or a vibrating bell, or even a telegraphic sounder, in circuit so that in case the insulated wire should at any point form a connection with the iron of the field magnets the fault will be detected. This may be effected by putting on the first convolution of wire and then joining the free end to one binding screw of the galvanometer or other detecting instrument From the other binding screw of the detector a wire is led to one terminal of the battery, the other terminal of the battery being placed in metallic contact with the iron of the field magnets. It will, therefore, be understood that if the wire that is being wrapped on the field magnets should in any place make metallic connection therewith the circuit will be closed and the galvanometer or other instrument will indicate the fact. Should this occur the wire must be unwound until the defect is discovered, when a piece of cotton, or better still, fine linen cloth must be wrapped around the bared place on the wire, before the latter is replaced.

Secure all the ends of the wires either to the neighboring coil or else by passing the finishing end beneath the adjoining layer and then drawing tight.[2] All the three, viz., the two field magnets and armature, are now ready to receive a coating on the insulated wire of thick shellac varnish. When dry, the machine may be finally mounted, and the ends of the field magnets so connected that the north pole of the one field magnet beds against the similar pole of the other field magnet.

When this has been ascertained, those two ends of wire should be cut short so that there is left just enough length to solder them together. This joint can then be insulated by binding round either cotton or tape, and carefully tucking same away so as to be out of sight as much as possible. One end of the field magnets is to be taken to one of the binding screws of the vulcanite (figure 22, page 47), and the other end goes to one of the brushes of the commutator. The other commutator brush has a short length of copper wire to the remaining binding screw. The machine is now ready for a test to ascertain how it runs. If carefully made, it will revolve with a single bichromate cell, though to get its full efficiency it will be necessary to employ six or eight bichromate cells, each cell having a zinc surface of 3½ in. wide and 6 inches long immersed in the liquid. With a small boxwood pulley on the shaft, and about ¾ in. to 1 inch in diameter and ½ in. in width, the machine is capable of driving a small lathe, fret-saw, or any light-running machinery.

Many persons have of late been writing against the Siemens H form of armature. For a dynamo from which a large amount of electrical energy is required, it certainly does heat after running a short time when made of large dimensions; but for small motors it is unquestionably the best, all things considered, and is by far the easiest for amateurs to fit together; and if made of the very best carburetted annealed iron, it does not heat to an extent sufficient to do any damage to the insulation of the wire.

(To be continued.)

1. *English Mechanic* (abridged).

2. It is hardly necessary to remark that the two ends of the armature coil should be brought out at the end of the armature, and carefully soldered to the inner ends of the two segments of the divided commutator. See fig. 18 p. 47 of this volume.—[EDITOR.]

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INCANDESCENT LAMP ECONOMY.[1]

BY ASSISTANT ENGINEER W. D. WEAVER, U. S. N.

THE cost of a given light from an incandescent lamp depends upon three quantities: the cost of the lamp, its life, and the cost of the energy to produce the light, the latter value being the entire cost of the energy actually delivered at the lamp, depreciation of plant and interest on capital being taken into consideration. The relation between these quantities may be formulated as follows:

Let a = the entire cost of one h. p. per hour *at the lamp.*
b = cost of lamp.
l = life of lamp.
x = candle power.

Then $\frac{b}{lx}$ is the hourly *lamp* cost of one candle-power,

$\frac{CE}{745} \times a \times \frac{1}{x}$ is the hourly *energy* cost of the same,

and $\frac{b}{lx} + \frac{a\,CE}{745\,x}$ is the *entire* hourly cost of the unit of light.

If now the relation between the electrical energy transformed in a lamp and the resulting candle power were known, the economic conditions in respect to the life and cost of lamp and cost of h. p., could be determined by means of the above formula.

There is, however, a great diversity of opinion in regard to the law connecting these two variables. Dr. Higgs states that the candle-power varies as the fourth power of the current, or as the square of the energy; Dr. Hagen (Dresden) gives the powers as five and three, respectively, while Mr. Preece, in a paper read before the British Association at Montreal, gave the law that the candle-power varies as the sixth power of the current.

The plotted curve has evidently the form of curves represented by the equation $y = kx^n$, and its regularity suggests that the law is not so variable as to give reason for the diversity of values hitherto given, a conclusion justified by the result of the following investigation:

I.

In the calculations the data used were those of the careful experiments made at the Crystal Palace Electrical Exhibition, contained in an able report on the exhibition made to the navy department by Mr. F. J. Sprague, late U. S. N.

The values of n in the formula $y = kx^n$ were calculated for both energy and current by means of the following equations, in which P is the candle-power, C the current, and E the electro-motive force between the lamp terminals:

$$n' = \frac{\log. P_2 - \log. P_1}{\log. C_2 + \log. E_2 - \log. C_1 - \log. E_1}$$

$$n'' = \frac{\log. P_2 - \log. P_1}{\log. C_2 - \log. C_1}.$$

The data used were those from experiments on 18 lamps, —six Edison, six Swan, and six Maxim; the value of n was calculated for each successive experiment between about five candle-power and the highest power noted that gave satisfactory results, and also for the extreme values of the candle-power for each lamp.

The results are as given in the following table:

	Number of Determinations.	n' $(P = KCE^{n'})$	n'' $(P = KC^{n''})$
Mean for successive values of C. P.	51	2.72	4.64
Mean for extreme values of C. P.	18	2.71	4.70

Adopting as the exponent of the energy the value 2.70, the probable error with the above data is between + .07 and — .03. The variation of the value of the exponent of the current is much greater, however, and, adopting the value 4.70, the probable error is + .30.

It would appear that n has a slightly greater value for the large filament or Maxim lamp than for the lamps with finer filaments; thus, with the former the mean values of n' and n'' are 2.75 and 4.97 respectively, and the variation small; this difference may be owing, however, to the more satisfactory data of the Maxim lamp, due to its larger range of candle-power.

Although the above values of n are probably correct within the limits given, other determinations should be made with smaller increments of candle-power than in the experiments at the Crystal Palace, and the variation of the exponent n, if any, determined for different-sized filaments.

The following table will show the agreement of the calculated with the observed candle-power. The figures at the head of the columns are from the report on the Crystal Palace exhibition, and were taken by the committee from curves plotted with observed data. The other values were calculated from the equation $CE = KP^{\frac{1}{2.7}}$ in which k was determined for the normal candle-power.

Lamp.	Normal Candle-Power.	k.	Candle-Power. 5	10	15	20	30	60	90
Swan....	20	21.36	5.52	10.40	15.30	20	30.18	61.51	97.60
Maxim..	20	26.98	6.18	10.67	15.17	20	29.95	58.30	94.63
Edison...	16	30.26	5.92	10.42	15	19.7	30.24	62.37	102.6

From the data of experiments made at the Munich Exhibition on the Gatehouse lamp, the following table was calculated, using the formula $CE = KP^{\frac{1}{2.7}}$:

Observed C. P..	5.89	8.40	11.12	15.3	21.93	30.76	41.52
Calculated C. P.	6.87	9.01	11.67	15.3	20.3	27.3	38.3
Differences	.98	.61	.55	0	-19.3	-3.46	-3.12

As might have been expected from the difference of construction of the lamp, the agreement is not very close, and the differences show that the equation to the curve of this lamp is of a less degree, and by calculation from the data given was found to be $CE = KP^{\frac{1}{3}}$, and the constant k, 25.58.

II.

Knowing now the relation between the candle-power and energy, we will return to our first formula,

$$\frac{b}{lx} + \frac{a\,CE}{745\,x} \qquad (1)$$

Expressing the law just deduced in the same notation, and substituting for CE in (1), we have finally for the whole cost of the unit light

$$y = \frac{b}{lx} + \frac{akx^{\frac{1}{2.7}}}{745\,x} \qquad (2)$$

With this equation, some interesting problems in incandescent lighting may be solved, and from it the following tables were deduced, showing the economic relation between the life of a lamp, its cost, and the cost of the energy furnished it. Table I. was constructed by assuming the life of a normal 20-candle-power lamp to be 1,000 hours, and that the lamp *when working at its normal capacity* would produce the normal light at the rate of three watts per candle-power, the cost of the lamp being taken at $1.00, and the cost of an hourly h. p. at 1 cent; from

1. *Van Nostrand's Engineering Magazine.*

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TABLE I.

$a = 1.$

Total cost of unit light per hour,

$$y = \frac{100}{20 \times 1000} + \frac{1 \times 60}{745 \times 20} = .00902$$

Candle-Power.	Cost of hourly H. P.	Watts. 2	2.5	3	3.5	4	4.5	5
10	1	2052	2607	3577	—	—	neg.	neg.
	2	—	neg.	neg.	neg.	neg.	neg.	neg.
	3	neg.	neg.	neg.	neg.	neg.	neg.	neg.
20	1	792	881	**1000**	1155	1364	1674	2160
	2	1367	2160	5138	neg.	neg.	neg.	neg.
	3	5138	neg.	neg.	neg.	neg.	neg.	neg.
30	1	479	518	564	618	684	766	869
	2	684	870	1195	1907	4706	neg.	neg.
	3	1195	2720	neg.	neg.	neg.	neg.	neg.
40	1	320	364	389	417	449	489	533
	2	420	533	654	846	1198	2132	—
	3	654	902	2053	neg.	neg.	neg.	neg.
50	1	266	280	295	313	334	355	380
	2	332	380	444	533	680	892	1344
	3	469	598	892	1801	neg.	neg.	neg.
60	1	216	226	237	249	263	276	292
	2	262	298	332	383	452	552	706
	3	332	414	552	827	1680	—	neg.
70	1	183	190	198	207	217	227	283
	2	216	239	266	300	344	403	488
	3	266	320	403	544	837	1806	neg.
80	1	158	163	170	177	185	192	200
	2	184	200	220	245	281	314	365
	3	221	259	313	398	541	858	2026
90	1	139	144	148	154	159	166	172
	2	160	173	188	207	228	255	290
	3	188	216	255	314	309	554	908
100	1	124	128	132	136	141	147	151
	2	141	151	163	178	195	218	240
	3	163	186	215	256	314	422	581

these data y was calculated and the life of the same lamp at other candle powers, and of other lamps of different efficiencies and at different candle powers was found, the cost of the unit light being the same in each case and as deduced from the above data. The watts at the head of the columns represent the efficiency of the lamp, and are the number of watts required to produce the unit light when the lamp is being used at its normal power—20-candle-power in each case; the figures 1, 2, 3 to the right of each candle-power are the respective costs of an hourly h. p., and enable a comparison to be made between the efficiencies at these different values, the cost of the unit light and of the lamp remaining the same. The other quantities are the lives that would have to be obtained in order that the cost of the unit light may remain the same as given for each table and therefore represent the relative efficiencies of different lamps at different candle powers and at the given constant cost of the unit of light. Table II. was calculated in the same manner, but assuming the cost, y, of the unit light to be that resulting when the energy costs two cents per hourly h. p., and in table III. the latter value is taken at three cents.

For any other cost b' of a lamp, the quantities in each table should be multiplied by the ratio $\frac{b'}{100}$.

If a relation could be established between different candle powers of a lamp and the resulting lives, by substitution in (2) and differentiation, the value of the candle-power could be obtained at which the cost of the unit light is a minimum. It is probable that an equation of the form $l = k(m - x)^n$ would approximately express this relation, m being the candle-power at which the filament is practically destroyed. As this important question from its commercial aspect appeals with especial force to those working large installations who have also the necessary facilities for making the experiments, it is probable that this final problem will soon be solved.

TABLE II.

$a = 2.$

Total cost of unit light per hour, $y = .01305$.

Candle-Power.	Cost of hourly H. P.	Watts. 2	2.5	3	3.5	4	4.5	5
10	1	1195	1272	1466	1724	2106	2696	3882
	2	2095	3822	—	neg.	neg.	neg.	neg.
	3	neg.	neg.	neg.	neg.	neg.	neg.	neg.
20	1	482	515	554	598	650	713	788
	2	650	788	**1000**	1367	2160	—	neg.
	3	1000	1674	3820	neg.	neg.	neg.	neg.
30	1	303	318	335	354	374	398	424
	2	374	424	489	577	704	902	1255
	3	473	634	902	1529	—	neg.	neg.
40	1	220	230	239	249	260	273	286
	2	261	286	318	358	409	480	571
	3	318	382	476	634	946	1908	—
50	1	173	179	185	192	199	207	215
	2	200	215	234	257	287	319	362
	3	235	270	319	410	510	695	1146
60	1	142	146	150	155	160	165	171
	2	160	171	184	199	216	236	267
	3	184	207	236	276	332	412	546
70	1	120	123	127	130	134	138	142
	2	134	142	152	162	174	186	205
	3	152	168	188	215	249	296	366
80	1	104	107	109	112	116	118	122
	2	115	121	128	136	145	156	167
	3	129	141	155	174	197	228	282
90	1	94	95	96	99	101	103	106
	2	101	106	111	118	125	132	141
	3	111	121	132	147	163	184	224
100	1	82	84	86	88	90	92	94
	2	90	94	98	103	109	116	122
	3	98	106	115	126	138	156	174

TABLE III.

$a = 3.$

Total cost of unit light per hour = .01708.

Candle-Power.	Cost of hourly H. P.	Watts. 2	2.5	3	3.5	4	4.5	5
10	1	798	841	927	1019	1137	1298	1496
	2	1136	1505	2165	3246	—	neg.	neg.
	3	5163	—	neg.	neg.	neg.	neg.	neg.
20	1	347	364	383	403	427	452	482
	2	426	482	554	650	788	1000	1367
	3	554	713	**1000**	1674	5138	neg.	neg.
30	1	220	230	238	248	258	269	280
	2	258	280	307	340	380	431	498
	3	307	359	431	537	724	1095	2247
40	1	165	167	172	178	183	189	196
	2	183	196	210	227	246	270	297
	3	210	236	269	313	375	468	614
50	1	128	131	135	138	142	146	150
	2	142	150	159	169	182	194	209
	3	160	175	194	224	252	289	346
60	1	105	108	110	113	115	118	121
	2	115	121	127	134	142	150	160
	3	127	138	150	165	184	206	235
70	1	80	91	93	95	97	99	102
	2	97	101	106	111	117	123	130
	3	106	114	123	133	146	161	180
80	1	78	79	81	82	84	85	87
	2	84	87	91	95	99	103	109
	3	91	97	104	108	120	131	144
85	1	69	70	71	72	74	75	76
	2	74	76	79	82	86	89	93
	3	79	84	89	95	102	110	123
90	1	62	63	64	65	66	67	68
	2	66	68	70	73	75	79	81
	3	70	74	78	83	89	96	102

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COMPARATIVE MEASUREMENTS OF THE ELECTRO-MAGNETIC ATTRACTION OF CYLINDRICAL AND BICONICAL CORES IN SOLENOIDS.

Mr. Krizik has stated it as a law that the force with which an iron bar is attracted into a helix is at its maximum when one end of the bar is at the longitudinal centre of the coil. Dr. E. Böttcher shows[1] that this law as a generalization is not correct and holds good only in special cases. The maximum of attraction and the corresponding position of the core in the solenoid, are dependent on the ratio of their respective lengths. If the core and the solenoid are of equal lengths, the maximum attraction takes place when the core is inserted three-quarters of its length within the solenoid. If the core is twice as long as the coil, the maximum attraction takes place when half the core is within the coil, and half without. If the core is three times the length of the coil, the point of maximum is when two-thirds of the core is out of the coil. These values hold good equally for cylindrical and biconical cores.

In Dr. Böttcher's opinion the biconical core possesses no advantage whatever over the cylindrical core, so that it is of no importance which is used in an arc lamp,—at all events in the case of a single lamp; and it is due to the differential arrangement of coils, originally introduced by Von Hefner Alteneck, that a longer core can be used for regulation of the arc.

For determining of the attraction exerted by a coil on an iron core in different positions, Dr. Böttcher made use of a Salter's spring-balance, from which was suspended an iron core 1 cm. in diameter and 20 cm. long. A solenoid, also 20 cm. long, was connected in circuit with a Schuckert dynamo, and was placed in various positions in respect to the core, both above and below it, but so as always to surround it. The following table gives the results where the figures are the weight in grammes corresponding to the attractive force exerted :

Length of core outside coil.	Strength of magnetizing current in ampères.		
	4	5	6
Cm.	Grammes.	Grammes.	Grammes.
15	6.5	10	14
10	13.0	18	27
5	14.5	20	30
1	6.5	10	14

The relation between attraction and the length of core is, perhaps, better shown in the following curves plotted from the above values—the abscissæ represent the length in cm. of the portion of the core projecting beyond the coil, while the ordinates measure the weight in grammes corresponding to the attractive force (see figure 1).

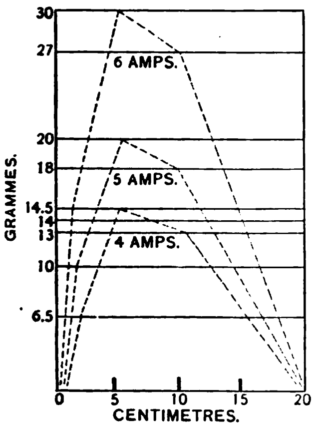

Figure 1.

He subsequently made some further experiments, from which the curves figures 2 and 3 are selected. These show clearly that there is no difference in the behavior of conical or cylindrical cores under similar conditions.

Dr. Dietrich, commenting upon the above results obtained by Dr. Böttcher, proposes the following inquiries :[2]

1. With reference to efficient regulation, what form of core is best for single lamps with one coil in the main circuit?

2. What result will be obtained, if in lamps with differential regulating coils the cylindrical core is replaced by a biconical one?

In discussing these questions, Dr. Dietrich considers only those lamps having no clamping mechanism, so that the core has a very long travel as the carbons burn away, and for a single lamp he takes as an example, Jaspar's. In this case we have in one direction the attractive force of the coil, and on the other an opposing force made up of the weight of the carbon, carbon - holder, core, etc. Both the attractive and the antagonistic force may be regarded as functions of the distance intervening between the centre of the core and the centre of the coil, and may be plotted on a system of rectangular co-ordinates.

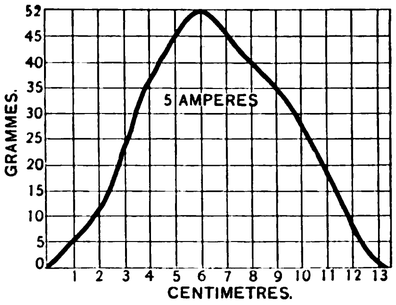

Figure 2.

If now a single lamp with one coil in the main circuit is to work properly, it must regulate for the same current at every position of the carbons; for only on this condition (the external circumstances remaining unaltered), can the length of the arc be made to remain constant from beginning to end of the burning. Hence in each and every position of the core, the attraction corresponding to the normal current must be equal to the antagonistic force, or, in other words, the curves of the attractive and of the antagonistic force must be identical. If this is not the case, then for different positions of the core equilibrium is only possible for different strengths of current, as is shown in figure 4, in which the curves J, J[1], J[2], represent the varying attractive power of the coil for varying currents, while the opposing force is represented by a single curve, since it remains constant. The abscissæ correspond to the distance from centre of core to centre of coil; and equilibrium can only occur at those points where the curve of attraction cuts the other curves. Hence the length of the arc will change as the carbons burn away and the core descends in the coil.

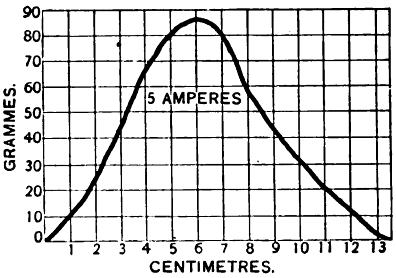

Figure 3.

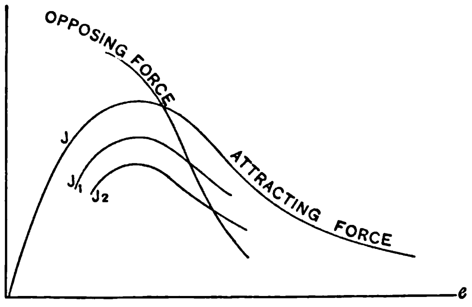

Figure 4.

The author arrives at the conclusion, in answer to his first question, that either a cylindrical or biconical core is equally efficient.

Upon consideration of the second question, it is clear that the curve of the attraction of the main coil corresponding to the normal current and the curve of attraction of the shunt-coil for a constant current in the shunt must also coincide. Now with cylindrical cores these two curves

1. *Centralblatt fur Elektrotechnik*, vi., 324.
2. Ibid. vi., 485.

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do not coincide, for the curve of the shunt coil forms an asymptote just at that point where the curve of the main coils falls suddenly, and *vice versa*. Accordingly, in order to equalize the two magnetic forces, either a mechanical force must be introduced, as for instance, by means of an eccentric wheel, or the cylindrical core must be replaced by one whose curve of attraction falls more quickly; and this is found to be the case with a biconical core.

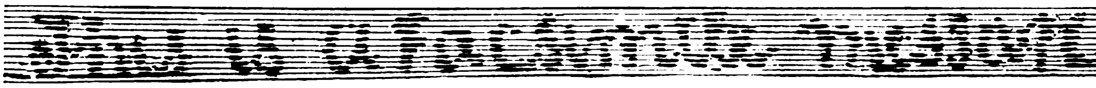
To sum up, then, for single lamps with one coil only, either form of core may be used; for several lamps in circuit with two coils in each, without a clamping device, the biconical form is preferable.

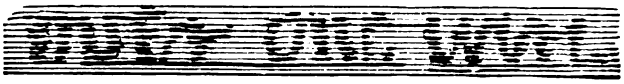
DELANY'S FAC-SIMILE TELEGRAPHIC TRANSMISSION.[1]

BY PROF. EDWIN J. HOUSTON.

It will doubtless interest the readers of the *Journal* to learn that Mr. P. B. Delany, the inventor of the first successful synchronous-multiplex telegraphic system, has fulfilled the promise he made a long time ago, and has practically applied his invention to fac-simile transmission, whereby the hand-writing of a correspondent, pen sketches, maps, plans, hieroglyphics, etc., can be sent over a telegraph wire and reproduced at the receiving station with all their distinctive characteristics.

I have had occasion, in previous articles on the synchronous-multiplex system, to call attention to the fact that the synchronous division of an ordinary telegraph wire into a number of parts, would eventually be applied to the transmission of fac-simile despatches. I have to-day received from Mr. Delany copies of the first fac-simile transmission with a crude experimental apparatus, which are herewith reproduced.





Although other systems of fac-simile transmission have been tried, and fac-simile despatches have been sent and successfully reproduced, yet when but a single wire was employed, the time required for the transmission was so protracted, and the uncertainty of correct reproduction so great, that such systems of transmission could never come into actual commercial use.

Mr. Delany's system, however, differs from the preceding in that it insures speed and certainty of correct reproduction. By means of the application of his synchronous system an area of 12 square inches can be covered in one minute by the use of a single wire.

The many uses of this system of fac-simile transmission can scarcely be properly appreciated at this time; for, notwithstanding the comparatively coarse lines that are so evident in the specimens annexed, yet with more carefully prepared apparatus, constructed for actual use, we do not doubt but that Mr. Delany will be able to transmit portraits, and other similar work equal in fineness to the ordinary wood-cut, so that criminals may be readily intercepted in their flight by the telegraphing of their portraits; or, in times of war, maps showing the movements of armies, sketches of fortifications and works may be transmitted; or the illustrated papers may be furnished, telegraphically with sketches of disasters, at the same time that particulars of the same are being transmitted to them.

An evident advantage of such a system of telegraphic transmission is in the readiness with which it can telegraph in any language, even Chinese, for instance.

CENTRAL HIGH SCHOOL,
PHILADELPHIA, February 20, 1885.

1. *Journal of the Franklin Institute.*

DYNAMO-ELECTROTYPING AT THE ORDNANCE SURVEY OFFICE.[1]

At the last meeting of the Society of Telegraph Engineers and Electricians a most interesting paper was read by Captain H. R. Sankey, R. E., on some experiments in electrotyping with a dynamo-electric machine, carried out at the Ordnance Survey Office, Southampton.

Electrotyping has been in use for the past thirty-seven years in the Ordnance Survey, in order to produce the copper clichés or plates from which the plans are printed. The original plates on which the survey is first engraved are thus preserved intact without being printed from. Inasmuch, however, as corrections and additions, such as new railways, are made on the electrotyped copy, the deposited copper of which it consists must allow of being engraved; and hence it is important to deposit a copper of uniform texture and without grit.

The practice of "backing" the electrotypes has not been adopted in the Survey. The matrices are made $\frac{1}{16}$ in. thick and the duplicates $\frac{1}{8}$ in. thick; the latter being of uniform thickness throughout in order to pass through the press.

In the older process the current for each depositing bath is supplied by one very large Smee cell. The results obtained by this method were excellent; but the process was expensive, and for this and other practical reasons, Captain Sankey undertook experiments with the dynamo-electric current. The average size of the plate to be deposited upon is 7 square feet; and to keep the deposit uniform the receiving plate or cathode is placed *below* the dissolving plate or anode, as the reverse arrangement is not found to

1. *Engineering.*

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answer well. The solution is kept in motion by gently rocking the baths.

In August, 1882, Mr. Elmore made some experiments with a dynamo in this direction, but the copper deposited was useless for the purposes of the Survey, as it could not be engraved upon.

These experiments were completed in July, 1883, and in January, 1884, Captain Sankey was instructed by the Director of the Survey to continue the experiments. His endeavor was to avoid working by mere "rule of thumb" in order to arrive at the best solution of the problem, which presented several new features. For the requirements of the Survey it was necessary that:

1. The density of the current should lie within certain limits.

2. The current should be kept constant during the deposition.

In order to satisfy the first requirement, he decided upon using a current of 30 ampères, because the current used in the existing arrangement as measured by Cardew's ammeter, was found to be from 23.4 to 26.4 ampères in different baths. Furthermore, 1½ lb. of copper per bath was found to be deposited in twenty-four hours, which corresponds to a current of 24 ampères.

To obtain a steady current from the dynamo during deposition, a high-speed engine and an electrical governor were requisite; and Captain Sankey, after careful consideration, selected a Willans six-cylinder compound engine and a Willans electrical governor. Both of these machines are found to answer admirably; the governor is extremely sensitive, and does not "hunt." It is in fact "dead-beat."

The question as to how the baths should be arranged had next to be settled; whether they should be placed "in parallel" or "in series" or in "combined parallel and series." The "parallel" arrangement was found unsuitable for the purpose owing to the difficulty of regulating the current. The combined arrangement was open to the same objection, and the series was found to be preferable to either, since one regulation of the current was sufficient. As Captain Sankey remarks, however, it does not follow that the series arrangement is preferable in all cases of deposition. For his purpose it was found the best.

The Elmore dynamo employed was originally arranged for working in parallel, by the coils being placed in parallel, but on placing them in series, or combined parallel and series, the electromotive force, it was thought, might be adjusted, and this proved to be the fact.

To find the electromotive force required the resistance of the baths was measured with a slide-resistance Wheatstone balance, and found to be 0.0087 ohm on an average. A reflector was used, and a commutor to overcome polarization. This bridge can measure 0.001 ohm to $\frac{1}{200,000}$ ohm.

The counter electromotive force was compared by the deflection method and a reflecting galvanometer with that of a Daniell cell and found to be 0.005 to 0.016 volt. Hence the electromotive force required per bath,

$$30 \text{ amp.} \times 0.0087 \text{ volt} + .016 \text{ volt} = 0.276 \text{ volt.}$$

This, therefore, was the electromotive force required at the terminals of the bath.

With regard to the number of baths, the output was to be 120 lb. per week; the dynamo had to work 44 hours; hence by a formula given by Captain Sankey,

$$x \times \frac{30 \text{ amp.} \times 44 \text{ hours}}{384} = 120 \text{ lb.}$$

where $x = 35$, the number of baths required. The total electromotive force required for the series of baths was therefore

$$35 \times 0.276 = 9.7 \text{ volts, or say, 10 volts.}$$

The dynamo was then tried and altered by Captain Sankey until it gave 10 volts and 30 ampères. The field magnets were placed in a shunt with the circuit; a coiled iron wire resistance being added to the field circuit by means of which the current could be kept constant, and also the speed, approximately, whilst the resistance, or in other words the number of baths in circuit was altered.

In these trials the current was measured by Cardew's ammeter, and the electromotive force by Poggendorff's method, using two Daniell cells with two porous pots and zinc cylinders between the pots to precipitate any copper finding its way through the first porous pot. The resistance was measured by the post-office pattern of Wheatstone's bridge. The following table gives the results of these tests.

EXPERIMENTS WITH ELMORE DYNAMO.

Armature.—Diameter, 1 ft. 6¼ in. Arranged in two sets of ten coils in series, the two sets being in parallel. Resistance cold, 0.0297 ohm.

Fields.—Twenty coils arranged in series. Resistance cold, 0.684 ohm. Placed in shunt with circuit.

Number of Experiment.	Revolutions per Minute.		Steam Pressure at Engine. Pounds per Square Inch.	Electromotive Force. Poggendorff's Method. Balancing Cells.		Resistances.			Difference Potential at Terminals of Dynamo.	Deduced fr. in Current.	Mean.	Resistance in Main Leads.	Current. Cardew's Ammeter, R = 1000 ohms. Constant, 18,280. Balancing Cells.			Resistance Unplugged in Box of Coils.	Current in Main Leads.	Deduced from E.M.F. and Resistance.	Mean.
	Dynamo.	Engine.		E. M. F.	No.	r_1.	r_2.	Of Leads to Dynamo.					E. M. F.	No.	Liquid Resistance.				
32	400	130	73	1.07	2	10	Not measured	0.67	..	6.0	..	0.38	1.07	2	10	1150	18.1		
33	500	170	35	1.07	2	10	42.0	0.67	11.1	11.5	11.3	0.38	1.07	2	10	280	30.4	20.2	29.8
34	300	100	80	1.07	2	10	2.4	0.67	2.7	2.8	2.75	0.34	1.07	2	10	3080	8.3	7.9	8.1
35	415	140	95	1.07	2	10	23.5	0.67	7.2	7.5	7.35	0.34	1.07	2	10	750	22.2	21.2	21.7
36	540	180	100	1.07	2	10	37.0	0.67	10.0	10.4	10.2	0.36	1.07	2	10	320	29.0	27.8	28.4
37	600	200	100	1.07	2	10	59.0	0.67	14.6	14.8	14.7	0.41	1.07	2	10	70	36.2	35.8	36.0
38	710	230	95	1.07	2	10	100.0	0.67	23.2	22.0	22.6	0.51	1.07	2	10	800	43.2	45.4	44.8

REMARKS.—The engine was worked compound for all experiments, except No. 33, when it was worked simple. An additional resistance of 0.85 was placed in field magnet circuit.

The solenoid of Willans's governor was then wound to take 30 ampères, and placed in series with one experimental bath, and a resistance equivalent to the rest. A Cardew's ammeter was placed in circuit to measure the current at intervals, and the governor was found to keep the current quite constant. The first plate was kept in the bath 31¾ hours, and the deposit weighed 1076 grammes of excellent copper. The corresponding current to this is 28.7 ampères; Cardew's ammeter showed 29.2 ampères. Captain Sankey, thinking this copper finer than that deposited by the Smee cell, tried the effect of increasing the density of the current by diminishing the size of the receiving plate gradually. The governor was adjusted to 30.5 ampères.

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The following results were obtained:

Current through Bath.	Size of Plate.	Density of Current.	Current for a Plate 2 ft. 4 in. by 3 ft. 4 in.	Quality of Copper.
	sq. ft.			
30.5	5.	6.1	47.0	good
30.5	4.	7.6	58.5	"
30.5	2.8	10.0	77.0	good; but rather rough at edges.

It therefore appeared that the current might be increased to 50 ampères.

At the same time that the above plates were being deposited upon, a matrix was laid down with the intention of producing a duplicate of the full thickness (⅛ in.); but this intention was given up, as it was found that without doubt the copper deposited by the dynamo was as good for the purpose of the Survey as that deposited by the Smee cell.

The experiments were thus brought to a successful close, and the fittings of the Survey Office at Southampton are now being altered for the removal of the Smee cells. The experiments on plates of 5, 4, and 2.8 square feet in area were made in a vertical bath. The solution being allowed to remain undisturbed at first, it became weak at the top and the resistance increased, but the current, however, remained constant until the throttle valve was fully open. Air was now blown in, rising from the bottom of the bath in large bubbles, and soon equalized the solution. Captain Sankey therefore hopes that vertical baths may be used for matrices; but they are unsuitable for duplicates because the deposit becomes thicker at the bottom. The arrangement of the baths is a very important step in Captain Sankey's experiments, and it will facilitate the use of dynamos for electrotyping, since it will allow of the employment of machines giving a considerable electromotive force and current, without having recourse to dynamos of expensive and special construction. The arrangement in series, as Captain Sankey pointed out, was adopted because it was found the best for the purpose in view, which was to deposit copper of a certain quality, not to deposit it in large quantities.

In the discussion which followed Captain Sankey's paper, Mr. Spagnoletti, Professor Forbes, and Mr. Crompton took part, the latter observing that the results there given were just those which dynamo makers required, and had not been able to obtain. Mr. Gisbert Kapp alluded to some experiments in which he had found the counter-electromotive force to be 0.7 to 0.9 volt. Professor Ayrton thought the counter-electromotive force could not be so high as that, and stated that Mr. Sprague (in Munro and Jamieson's electrical pocket-book) had given it as 0.02, or nearly the same as 0.016, which had been found by Captain Sankey.

Captain Sankey illustrated his paper by a number of excellent samples of copper deposited by dynamo currents of densities ranging from 3.6 to 10 ampères per square foot; and also some deposited by Smee cells, including a matrix of part of the map of London, and a plate deposited by a current too strong and showing signs of granular structure. Samples of copper deposited by Mr. Elmore with a dynamo were likewise exhibited. A proof sheet of the Isle of Wight, in four sheets recently joined together, was exhibited to show that the deposited copper must be capable of being engraved. The matrices of the four sheets were cut and joined by soldering and riveting, then a duplicate deposited. The plate has to be engraved along the junctions. The Daniell cells and Willans governor employed in the experiments were also exhibited to the meeting.

THE ELECTRIC LIGHT ON THE BRIGHTON RAILWAY.[1]

BY W. SLINGO.

Amidst the many inconveniences that await the average railway traveler, there is, to my mind, not one that is more trying or vexatious than to be compelled to sit out a long journey in a carriage illuminated (!) by the old, dirty, smoky oil lamp. Nevertheless, until very recently, this is what one and all had to do whose business or pleasure involved them in a railway journey at a time when sunlight was absent; and even now we are oftener than not compelled to undergo the same torment.

The introduction of the Pintsch gas system wrought a revolution on a small scale. Our underground railway trains are fitted under it, and it has found support in a few other directions. But the greatest result, perhaps, which has been brought about by even a limited application of the system is that it has shown the public that a light superior to that given by oil is practicable; and, were nothing else available, the railway companies would, sooner or later, be compelled by force of public opinion to adopt it.

There is, however, something which is superior to gas even in a railway carriage, and that something is electricity. We certainly owe it to the eminently able and enterprising management of the London, Brighton, and South Coast railway that electricity, as an illuminating agent in railway carriages, has been proved; for the first experiments in this direction were made by that company some three years ago, when the Pullman express, which runs daily between the Victoria and Brighton stations, was lighted by electricity. In that case accumulators of the Faure type—some of the very first brought into England—were employed.

They were charged overnight at Victoria by means of a dynamo worked by a gas-engine (wires being led from the shed to the brake-van), and supplied throughout the day sufficient current to illuminate the 28 lamps fitted in the various carriages composing the train, which performed the journey from London to Brighton and back twice daily.

The advantages of the system over the previously employed oil lamps were, it is almost needless to say, too real and too apparent not to secure at once the admiration and gratification of the patrons of the line. The light was steady, clear, and only showed itself when wanted.

Illumination by oil or gas means that in the day-time, if the train has to run a 50 mile or even longer journey, and has one or two short tunnels to traverse, the lamps must all be burning through the entire length of the journey on account of the tunnels.

With the electric light this is not the case. The guard is provided with a simple switch, by turning which he is able to send the current into the lamps on approaching a tunnel, and to stop the current on emerging from the tunnel. Here, then, is a very decided advantage in favor of electricity.

The train thus fitted has continued its daily journeys since the inauguration of the system, but there were soon discovered many features in connection with it that required modification before it could become the commercial success that was hoped for it. In the first place, there was the expense of the gas engine and its attendant. This is a serious objection, to say nothing of the allowance that ought to be made for renting the engine house. It may, however, be observed that, were the system extended to several trains instead of a single one, so as to divide the engine and accessory expenses between them, the cost per train would obviously be considerably reduced.

In the following year a new system was introduced, and employed on the London-bridge and Brighton express, and on a local train running between Victoria, Crystal Palace,

1. *Knowledge.*

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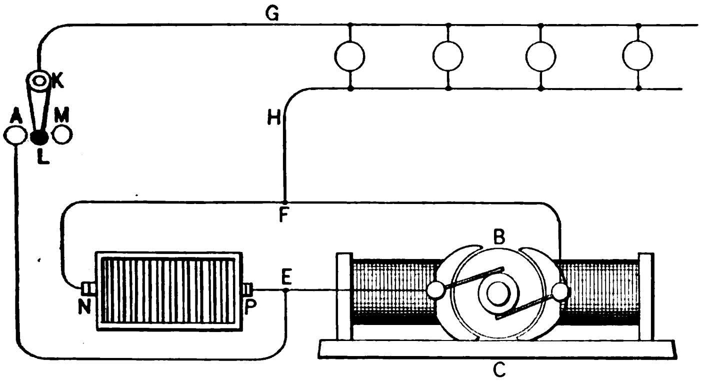
and London-bridge, &c. It had been worked out by Mr. Stroudley, the talented engineer to the company, and Mr. Houghton, its energetic telegraph superintendent. In this system the engine was discarded entirely, and the dynamo was fixed in the brake-van, and worked from a countershaft geared on to one of the axles. While the train travels at a sufficiently rapid rate, it is easy to see that the dynamo might be driven fast enough to feed the lamps. But whence is the electricity to come necessary to illuminate the lamps when the train is traveling slowly or when it is standing still? This is accomplished in a very simple



Train Lighting System.

manner. While the train is running rapidly, electricity may be generated, whether the light is wanted or not. Consequently, the dynamo, B C, is permanently connected to a set of 20 accumulators, N P. Other wires, however, are connected at E F to the wires joining the dynamo to the accumulators, and these other wires are connected to the lamps in the various parts of the train. It follows that, were there no electrical energy stored in the accumulators, the current from the dynamo would divide between them and the lamps. The accumulators are never wholly discharged, however; but, even were they so, sufficient charge would soon accumulate to prevent this division, for it must be remembered that electricity, in charging accumulators, sets up a "counter electro-motive force," and if this force is equal to that of the generator no electricity will flow into it, although a very small difference is sufficient to maintain a current. Moreover, when the lamps and accumulators are all in circuit, but little electricity will flow into the latter, because the "difference of potential" between the dynamo and lamps is equal to that between the brushes of the dynamo itself, while the "difference of potential" between the dynamo and accumulators is only a fraction of that amount; and, as the greater proportion of electricity flows between point of greater difference of potential, nearly the whole current produced will be absorbed by the lamps.

A switch is provided in the lamp circuit, so that the guard may be able to disconnect it when the light is not required. The current will then be utilized by the accumulators. In the diagram, K L is the handle of the switch hinged at K. When L is over A, the lamps are disconnected, but when it is over M, they are in circuit.

One great feature of the Stroudley-Houghton system is the automatic controlling apparatus. This originally took the form of a governor, which was fitted in November, 1883; but in August, 1884, the work in the local train was transferred to a mercury pump. This consisted of two vertical tubes, the lower ends of which opened into a cylinder. In this a coarse-threaded screw was made to revolve by being connected to a small pulley-wheel, over which passed a strap, which also passed round the spindle of the dynamo. When the train was in motion the pulley-wheel revolved, and with it the screw in the cylinder. The cylinder and lower portions of the tubes being filled with mercury, the revolution of the screw caused the mercury to fall in one tube and rise in the other. At a certain height in each tube, above the normal level of the mercury, was an adjustable contact point, and the mercury, on reaching one or the other, completed the dynamo's exciting circuit. When the train traveled in one direction, the pulley-wheel traveling with it would bring about the rise of the mercury in one tube; when it traveled in the opposite direction the mercury would rise in the other tube. The "shunt" circuit thus closed, in turn joined up the main circuit automatically.

There was another and most important function pertaining to the mercury pump. The electromotive force produced in the coils of a dynamo varies with the speed at which the armature rotates. Accordingly, when running slowly (or not running at all), the accumulators would have a higher electromotive force than the dynamo, and if the circuit between them were complete, the former would discharge themselves through the coils of the machine. The mercury pump, however, prevents this. The gearing which drives the screw is so arranged that the mercury is made to rise in one of the tubes only when a speed of 12 miles an hour is attained. At that speed the dynamo runs fast enough to produce the necessary electromotive force.

The dynamo originally used was one of Messrs. Siemens' machines (type D 2). After some months, this was superseded by a Brush machine, provided with a Schuckert armature; but any dynamo having the necessary electromotive force can be employed, and it is now proposed to use dynamos which are free from the chief disadvantage of a Brush machine—viz., that it will not respond to demands for an increase of current in emergencies. The current produced is one of 56 ampères, with an electromotive force of 45 volts. A double set of "brushes" is provided, in consequence of the frequent change in the direction in which the armature rotates, and they are so fitted as to work automatically.

The 32 accumulators originally fitted were of the first type of Faure cell, which did not answer so well as was hoped, but those now employed give every satisfaction, test well, and have been in daily use in the Pullman limited express since December, 1882, showing a result in every way satisfactory. There is this to be said, that the vibration of the train may be calculated to do them more good than harm.

There are in the express train 56, and in the local train 36 Woodhouse and Rawson incandescent lamps, each taking about 1·15 ampères, with an electromotive force of 40 volts. Other lamps have been tried, but Mr. Houghton's experience is that their carbon filaments are too fragile to withstand the vibration of the train, while the lamps now in use have answered every requirement for the past 11 months.

A train fitted up on the Stroudley-Houghton system has lately started running on the South-Eastern railway, between London and Maidstone.

The weight of the accumulators is about 22 cwt., and of the dynamo eight cwt., making in all 30 cwt.

The local train, which offers certainly the severest test, has been running continuously for 14 months, making about 3,200 trips, and running about 40,000 miles, giving during that time every satisfaction. The trains have been equipped by the Railway Electrical Contractors (Limited), 4 Great Winchester Street, E.C., and the result speaks well for the managing director, Mr. T. M. Collet.

With reference to the relative cost of the system, complete details cannot be given. The cost of the oil previously consumed and wasted is saved, and this is a considerable item. There is no cost for lamp cleaners, as the lamps require no cleaning. The energy absorbed by the lamps is but three electrical h. p.; and, making the widest allowance for waste in the dynamo and bearings, the additional consumption of coal in the engine is small. As a matter of fact, the driver is unable to detect any difference in the consumption; and many a time has it happened that

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the driver has not been aware of the fact that he is lighting the train as well as drawing it, until he has arrived at the end of his journey. Practically, then, the cost of the light is almost reducible to depreciation of stock (wearing out of dynamo and accumulators, breakage of lamps, &c.) and interest on capital outlay. Labor costs but a tithe of that which is necessary for oil lamps, all that is required being occasional inspection and lubrication.

It is earnestly to be hoped that the success of the enterprise will increase, and prove in every sense of the word satisfactory; and that the day may not be long in coming when we shall regard oil lamps as another relic of the "good old times."

THE ELECTRICAL TRANSMISSION OF POWER IN MINES.[1]

In his work on this subject, Professor W. S. Schulz furnishes several interesting tables; one of them gives the results of electrical transmission already realized in the mines:

Name of mine.	Power of the moto[r] in h. p.	Machine actuated.	Length of conductors. Mètres.	Per cent. of efficiency. Electrical.	Mechanical.	Total.
La Perronière, near Rive-de-Gier	37.1	Traction machine.	1,500	50	37	30
Thibaut, near St. Etienne	5.0	" "	250	45	38	25
Blanzy	17.0	" "	634		51	30
Zankeroda	14.7	Locomotive.	893	46.6	37.8	30
"	5.0	Ventilator.	780	50.	.26.	
St. Claude, near Blanzy	8.1	"	900			

Taking these results as a basis, the author compares the cost of the electrical transmission of force, with that of the transmission by means of compressed air and of water applied to drills and to machines for the extraction of coal by means of locomotives, of hoisting machines and by means of ventilators. He finds thus that the first method is more costly than any of the others, except that which employs air compressed by steam without cooling, as well as locomotives for towing on a level. The following table gives the comparative costs of a system of transportation of this kind, in operation:

SUBTERRANEAN TRANSPORTATION BY LOCOMOTIVES.

	Steam.		Compressed air.		Electricity.
	Dornan mine.	Cesson mine.	Petan system.	Mékarski system.	Zankeroda mine.
First cost of installation (francs)	40,000	40,000	16,250	25,000	20,000
Interest, etc., per ton-kilomètre (centimes)	2.64	0.9	4.90	5.02	2.76
Cost of transportation (centimes)	3.72	3.16	7.36	8.41	6.80
Total cost (centimes)	6.36	4.07	12.26	13.43	9.56
Daily work (tons-kilomètres)	488	1,421	106	159	235
Length of line (mètres)	2,320	4,627	620	620	620
Speed	2.3	3.3	1.5	1.5	2.6
Weight of machine (kilogrammes)	4,400	8,000	2,700	2,300	1,600
Height (mètres)	1.92	2.1		1.55	1.5
Width (mètres)	1.30	1.6		1.10	0.8

For the separate ventilation of a lateral cutting in the Zankeroda mine, there is employed a Schiele ventilator of 40 inches, fed by a Siemens dynamo driven by a Dolgorouki steam engine; the cost is 2.0 centimes per 1,000 cubic mètres, which is a better return than from the transmission of compressed air, except when it is necessary to make a special installation for compression for the small ventilator. The author concludes that mines do not offer a promising field for the electrical transmission of force, outside of some isolated cases, and except for transportation by locomotives on level ground, where it may advantageously replace traction by rope or cable.

1. *La Lumiere Electrique*, xv., 91.

PROGRESS OF THE ELECTRIC RAILWAY.

We note that electric railways are making steady progress in Great Britain. The line at Portrush (Ireland) has now been opened a year, and has proved so great an attraction that the number of visitors to the Giant's Causeway has been increased tenfold. The line runs through very pretty coast scenery, but is a difficult one to work, being a succession of heavy gradients and sharp curves, with practically no level ground for the whole six miles. The turbines answer admirably as the source of power; and the River Rush never fails in the dryest season. At Newry, a town midway between Belfast and Dublin, another electric railway is being constructed by the Bessbrook Spinning Company, the length of which will be about three miles. Two gangs of men are busily engaged in grading and bridging, and the rails have been laid for a considerable distance. As soon as the track is completed Dr. Hopkinson, for the firm of Siemens Brothers, London, will commence the work of erecting the electrical machinery, which will be placed in an old flour mill situated in Millwall, about midway between Bessbrook and Newry. The opening ceremony is expected to take place early in the year. Active preparations are also being made to open a system of electrical tramways at Blackpool, which, in anticipation at least, are to surpass everything hitherto attempted; and it is hoped that the work will be completed early in the spring. A deputation of the local authorities of Blackpool recently visited the Brighton electric railway. For electric railways at the Novelties Exhibition next year no less than three distinct applications to exhibit have been made; but the limited space available will doubtless prevent their being granted. The Brighton electric railway, during the height of the fashionable season, was crowded for several hours daily, and arrangements are being made to run extra cars, passing on a loop half-way along the line.

THE UNIT OF LIGHT.

The English standard candle and the French carcel are both unsatisfactory and unreliable, and many attempts have been made to substitute for them a more perfect standard of reference. The proposal to employ a square centimetre of platinum at the point of fusion, recommended a few months ago at Paris, is too impracticable and uncertain for general adoption, but this objection does not apply to the unit proposed by Dr. Siemens, and discovered by Hefner-Alteneck. This standard is the light given by burning acetate of amyl in an open burner at such a rate that after ten minutes the dimensions of the flame are, diameter $\frac{5}{16}$in.; length, 2.6in. This fluid boils at 138.6° C., and is inexplosive and therefore perfectly safe. There are various other similar substances that may be employed with equal accuracy, and they all appear to possess the advantage that they may be burnt with a hard or soft spun wick which may be accurately or carelessly trimmed. These substances are the valerianates, acetates or formiates of amyl, isobutyl and ethyl. Their relative luminous values and the seconds required to burn one gram are given in the following table:

	Luminosity.	Time.
Acetate of ethyl	1.24	212
Valerianate of amyl	1.03	436
Formiate of amyl	1.01	372
Acetate of amyl, pure	1.00	388
Acetate of amyl, coml	1.00	388
Acetate of isobutyl	.99	373
Formiate of isobutyl	.97	455

Hence it appears that the commercial acetate of amyl may be employed equally with the pure, the price of which at present is about 9d. per oz.—*Mechanical World.*

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McDONOUGH'S TELEPHONIC INVENTIONS.[1]

BY PROFESSOR EDWIN J. HOUSTON.

The pioneer work done by Reis in the development of the articulating telephone, quite naturally attracted the attention of numerous investigators and inventors in different parts of the world, and resulted in the production of various forms of apparatus intended for the electrical transmission of speech. Among the earlier investigators in this field the name of James W. McDonough occupies a prominent place.

McDonough came prominently before the scientific men in this country as a party to the famous telephone interference suits, declared in the United States Patent Office during the last eight or nine years. On the 10th of April, 1876, McDonough filed an application in the United States Patent Office for a "Teleloge, or a means for transmitting articulate sounds from one place to another through the medium of electricity." This application was placed in interference with the patent of Bell, dated March 7, 1876, and afterwards with the following applications; viz., that of Edison, of December 24, 1877; Dolbear, October 31, 1877; Richmond, August 24, 1877; Gray, October 29, 1877, and Holcombe, January 28, 1878.

The applications of the above parties, together with those of Berliner, Voelker, Blake and Irwin were placed in interference with Bell and with one another, and formed a long series of interference suits that have not yet been finally decided.[2] McDonough was admitted to the above interferences on the subject-matter of his receiver only. For reasons we shall afterwards refer to, he was excluded by the Office from participation in the other interference suits. The case in which he was a party was known in the Office as case G.

The subject-matter of this case was "Held to embrace a receiver containing an electro-magnet and a diaphragm supported and arranged in close proximity thereto, and adapted to respond to variations in the electric current passing through the coils of the magnet when used in connection or combination with a transmitter adapted to create sound-producing fluctuations in the electric current, whether said electrical variations, waves, pulsations, or undulations represent, or are derived from, sound-waves, or mechanical vibrations."

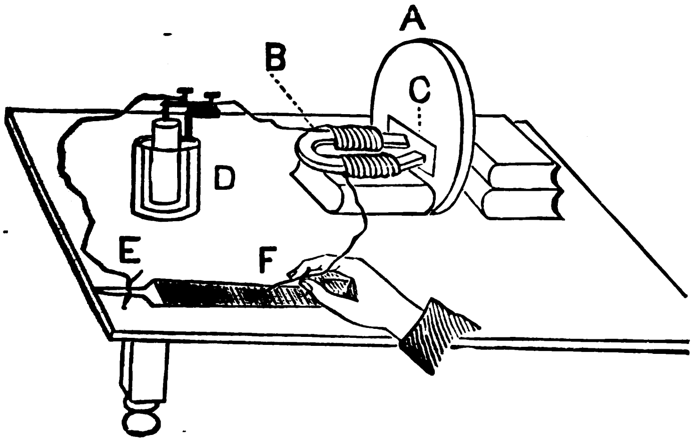

FIGURE 1.—Apparatus of 1867, for obtaining Sounds by Interrupted Currents.

The above interference involved the extremely important issue as to the true inventor of the telephone receiver. After a long and thorough examination of the case it was decided by the Examiner in Interference cases by the awarding of priority of invention to McDonough. On appeal, however, to the Examiners-in-Chief, this decision was reversed and priority of invention awarded to Bell. The case is now on final appeal to the Commissioner of Patents, and awaits his decision.

Although the application of McDonough was made on the 10th of April, 1876, or after the issue of Bell's patent, of March 7, 1876, yet it was made before the date of Bell's lecture, May 10, 1876, or before the actual introduction or use of his articulating telephone. "So that," says the Examiner of Interferences, "McDonough's efforts in this direction may be regarded as entirely independent of and uninfluenced by Bell's disclosures and inventions."

Before describing McDonough's application of 1876, we will give a brief account of his experiments and inventions leading thereto.

According to a sworn deposition made by McDonough in a telephone suit, his first experiments bearing on the subject of telephony were made in 1867, when he constructed an apparatus by means of which he was enabled to obtain a continuous sound by means of an interrupted current of electricity. This apparatus, which is shown in figure 1, consisted of a horseshoe electro-magnet, B, placed before a paper diaphragm, A, tightly stretched over an iron hoop. On the paper diaphragm, facing the poles of the horseshoe magnet, was attached a small piece of tinned iron, C. The diaphragm and magnet were suitably supported on books and placed in the relative positions shown in the figure.

One terminal of a battery cell was connected with one of the terminals of the magnet coil, and the other terminal, E, of the battery was wrapped around the end of an ordinary file, F. When, now, the free terminal of the horseshoe magnet was drawn over the surface of the file, the makes and breaks thus effected in the battery current, produced fluctuations in the magnetism that corresponded with the fluctuations thrown on the electric current traversing the magnet coils, and thus produced movements in the diaphragm. A movement of contact, effected when the terminal touched the file, permitted the current to flow, and thus resulted in the attraction of the tinned iron to the magnet. A movement of the contact away from the file, causing a break in the circuit, permitted the diaphragm to move from the magnet in consequence of its elasticity. With this early apparatus, McDonough was able to produce sounds that were audible at a distance of several feet from the diaphragm. The pitch of the sounds produced, of course varied with the rapidity of motion of the wire over the file. Unfortunately McDonough does not appear to have preserved this early form of apparatus. All of it that remained in his possession in 1876, was the magnet, and the iron ring on which the paper diaphragm was stretched. Nor does he appear to have shown this experiment to others. At least he brings no witnesses to testify to having seen the parts assembled in the relations shown in figure 1.

Assuming, as we may fairly do, when taken in connection with subsequent apparatus that was shown to competent witnesses, that McDonough actually produced the combination of parts shown in figure 1, at the date alleged; viz., in 1867, then *great* credit is due him for the decided invention thus effected, since he has produced what may be fairly regarded as a new combination of parts whereby improved results can be obtained. For, when, at a later date, he placed such a magnetic diaphragm in combination with a telephone transmitter varied by the voice, he did much to place the articulating telephone in its present successful commercial position.

When we speak of the preceding combination of parts being novel when used to produce sounds by means of varied currents of electricity, we are not unmindful of the experiments of Page, in 1837, who obtained musical sounds from a magnet when an interrupted current was passed through a flat spiral placed between the poles. These early observations, which were confirmed by more extended experiments of De la Rive, and of Delezenne, were ascribed to molecular changes in the iron during its magnetization

1. *Journal of the Franklin Institute.*

2. On March 3, 1885, after the above was written, the Commissioner of Patents rendered a decision awarding the priority of invention to Bell on all matters of importance, including the receiver which the Examiner of Interferences originally awarded to McDonough. This decision is final so far as the Patent Office is concerned. [*Editor.*]

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and demagnetization. In the McDonough experiment, the movements of the diaphragm producing the sound are not molecular, but mass vibrations. The entire diaphragm moves to or fro under the variations in the magnetic attraction. It is such a form of diaphragm that practice shows to be so valuable when used as a receiver for the articulating telephone. McDonough does not appear to have done anything more with his apparatus than to have tried its capacity for producing sounds, more or less continuous, by the action of an intermittent current. Although he may have vaguely conceived the possibility of applying the apparatus to the transmission of articulate speech, yet such conceptions do not seem to have taken definite form until August 26, 1871, when he made the sketch that is represented in figure 2.

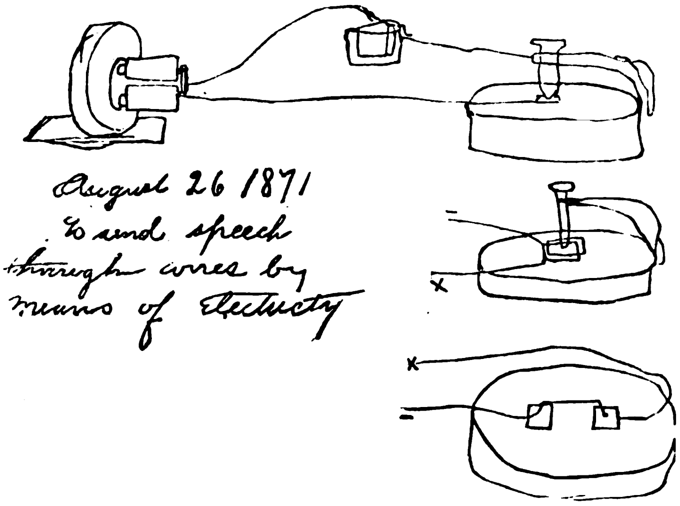

FIGURE 2.—McDonough's Sketch of August 26, 1871.

This sketch, which was made in a memorandum book containing sketches and suggestions respecting some thirty different inventions, was the result of an idea conceived by McDonough after reading descriptions of the phonautograph, and of the Reis telephone. The legend of the sketch, "To send speech through wires by means of electricity," clearly indicates the purpose of the apparatus. No other description accompanies the drawing, and in interpreting it we must bring to bear on it such a knowledge of the state of the art only, that it is fair to suppose was possessed by McDonough at the time he made the sketch. As to the apparatus shown on the left hand, its purpose is obviously the same as that of the experiment of 1867. The apparatus shown in the middle of the upper drawing is clearly a battery, since it is stated that the combination of parts is to be operated through the agency of electricity. As to the various forms of apparatus shown on the right hand of the sketch, they are apparently diaphragm-transmitters of the Reis type, designed to be used in the manner fully described by Reis. Moreover, the apparatus shown in the lower, right hand sketch is substantially the form of transmitter figured in his application of April 10, 1876. Since McDonough was acquainted with the experiments of Reis, and had experimented as to the ability of a magnetic diaphragm to be set into motion by means of a varied electrical current, it is fair to suppose, admitting the credibility of the sketch, that he intended to combine his magnetic diaphragm, with a voltaic battery and a modified Reis transmitter. McDonough does not appear to have actually embodied his invention in a working model until the latter part of May, 1875. This delay was owing to ill health, change of residence, and great press of other business. In May, 1875, however, he constructed his first telephonic apparatus. The membranes of the transmitting and receiving instruments were stretched over the ends of two cylindrical tin cases. A piece of tinned iron was fastened on the diaphragm of the receiving instrument, and the poles of an electro-magnet were placed in proximity thereto. Near the centre of the diaphragm of the transmitting instrument was secured a small piece of tin-foil. This diaphragm was suitably supported in a horizontal position. A needle, passing through a glass tube supported in a vertical position over the diaphragm, rested with its lower end on the plate of tin-foil. The needle was free to move up and down, and formed one of the terminals of a battery, the other terminal being connected with the line. This form of apparatus was somewhat modified in June, 1875, when the form given to it was as shown in figure 3.

In this form of apparatus the tin-foil was replaced by a small plate of german silver. A, represents the tin-can receiver, with its diaphragm, C, and plate of tinned iron, E. The electro-magnet, F, is adjustable with reference to the diaphragm. The transmitter consists substantially of the tin can, B, on the diaphragm of which is placed the german silver plate, H. The glass tube, J. contains the contact needle. The connections with the battery, G, are as shown. With the preceding apparatus, familiar tunes were successfully transmitted, but no words.

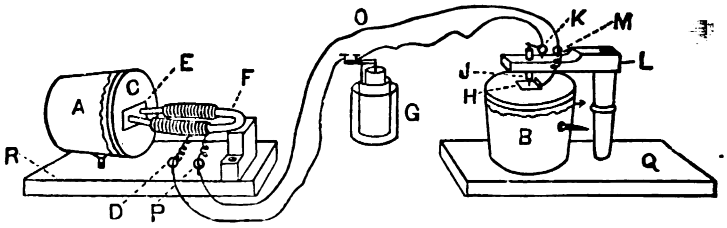

FIGURE 3.—McDonough's Telephonic Apparatus of June, 1875.

Figure 4, shows the details of a modified form of apparatus constructed by McDonough later, in June, 1875. The membrane, A, is stretched over an iron hoop. B, is an iron plate, fastened to the diaphragm. The electro-magnet, C, is securely mounted, in the position shown, on an adjustable standard.

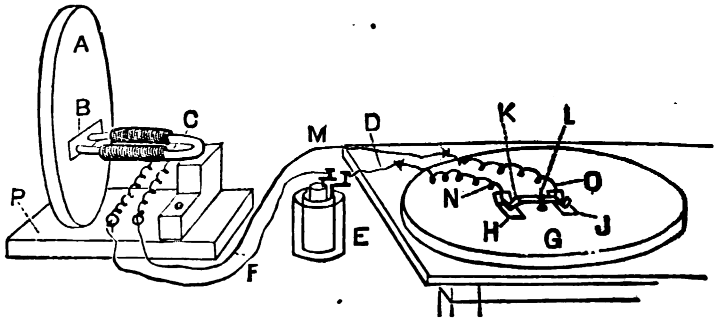

FIGURE 4.—McDonough's Later Telephonic Apparatus of June, 1875.

The transmitter consists of a parchment diaphragm, G, stretched over an iron hoop or ring. Two metal plates, H and J, of german silver, are securely attached to the diaphragm, about an inch and a half apart and connected with the wires, N, and O, as shown. A light strip of metal, K, bent in the form shown, rested on the metallic plates, H, and J, and completed the electric circuit between them. The bolt, L, with a nut for adjustment, was subsequently added in order to prevent the vibrations of the diaphragm from moving the metallic bridge, K, away from the metal plates, H, and J. One of the above mentioned iron hoops was the one employed in the experiment of 1867.

The above apparatus, which was completed about the middle of June, 1875, was successfully employed for the transmission of articulate speech on many occasions during the same month. A number of witnesses testify to having heard articulate speech by the use of the preceding instruments. Only parts of the apparatus of June, 1875, were

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preserved. These were used as exhibits in the United States Patent Office interference case with Bell and the other parties mentioned. The instruments, however, were reproduced with all the exactness possible, and are represented in figure 5. This apparatus has been successfully used by several parties for the transmission and reproduction of articulate speech.

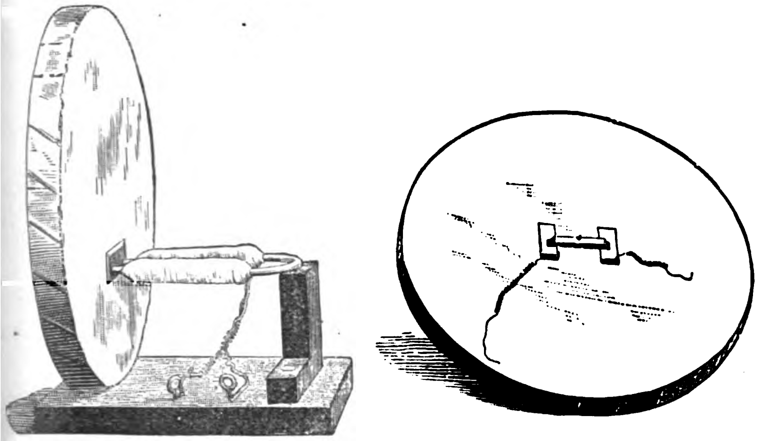

FIGURE 5.—Reproductions of McDonough's Telephone of June, 1875.

Having satisfactorily shown the capability of his instruments to transmit articulate speech, McDonough set to work to improve the strength of the sounds reproduced by the receiver. Prior to the filing of his application for a patent on the 10th of April, 1876, he constructed and carried on numerous experiments with some 15 different instruments, frequently interchanging the transmitters and the receivers.

We will describe a few of the more important of these early forms of articulating telephones. Figure 6, shows an instrument constructed and used by McDonough in September, 1875.

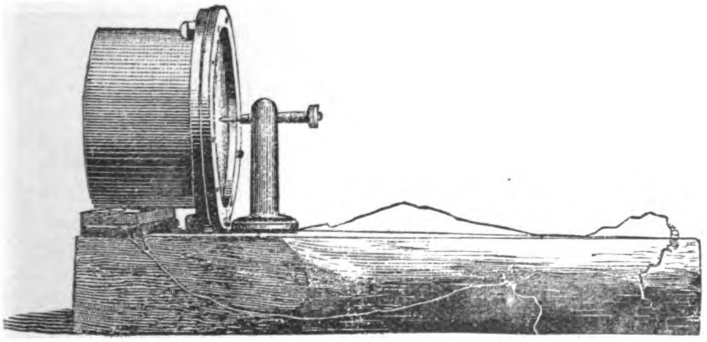

FIGURE 6.—McDonough's Metallic Diaphragm Transmitter, September, 1875. (Exterior.)

The diaphragm in this instrument is mounted on a brass cylinder, and unlike the previous diaphragms, is metallic, being made of a thin sheet of german silver. The arrangement by means of which the diaphragm is firmly clamped in position on the end of the brass cylinder, is shown in the drawing. Directly opposite the centre of the diaphragm an electrical conducting cylinder, or electrode, was supported so as to be in contact with the diaphragm at one of its ends. This electrode was supported by the vertical post placed in front of the diaphragm, and was furnished with an adjusting screw so as to permit its position as regards the diaphragm to be varied at pleasure. The too free vibration of the diaphragm was prevented by means of a screw whose bearing was in a transverse bar. This clamping device is shown in a rear view of the same apparatus in figure 7.

One of the circuit wires was connected with the metallic diaphragm and the other with the contact electrode. Various materials were employed for the contact electrode, such, for example, as nickel, german silver, platinum, steel and carbon. The latter, which appeared to give the best

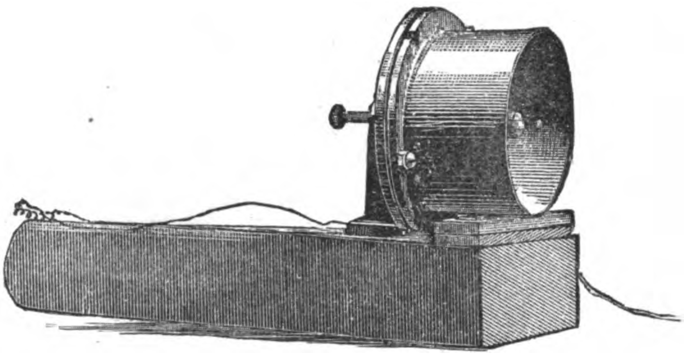

FIGURE 7.—McDonough's Metallic-Diaphragm Transmitter, September, 1875. (Interior.)

results, was formed of the graphite of an ordinary lead pencil. The transmitter of September, 1875, was used in connection with the receiver of June, 1875, as well as with other receivers.

A later form of transmitter and receiver was constructed by McDonough in October, 1875, and named by him "The tin-drum pendulum" instruments. These instruments are shown in figure 8.

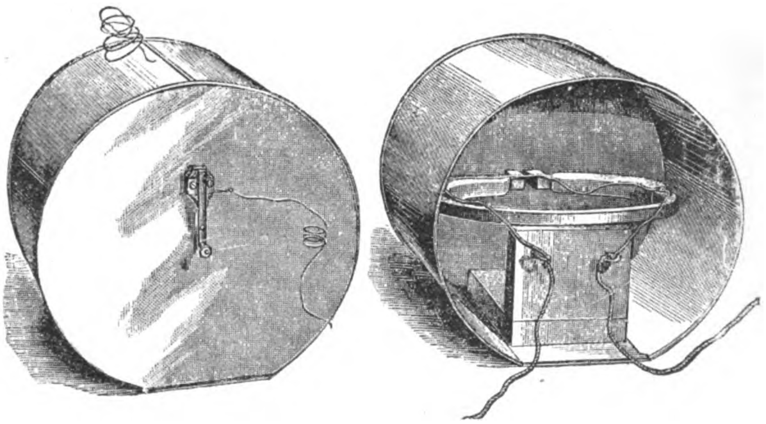

FIGURE 8.—McDonough's Tin-Drum Pendulum Transmitter and Receiver, October, 1875.

The transmitter of this set of instruments consisted of a tin-drum or cylinder flattened on one side, and enclosed at one end, which formed a diaphragm; at the centre of this diaphragm a small piece of platinum was soldered and formed a contact point for an electrode, which, as before, was formed of various materials such as platinum, steel, brass or carbon. The electrode was "inserted in a socket formed in the end of an adjustable screw, which was carried by a hinged pendulous bar of brass, about two and one-half inches in length. The pendulous bar was so hinged as to press the electrode in towards the platinum." The details of this device will be the better understood from an inspection of figure 9, which shows another view of the transmitter. The hinged end of the pendulous brass bar was supported on any insulating material. One terminal of the line was connected to the pendulous bar and hence to the contact electrode, and the other end to any part of the tin-drum, and therefore to the platinum plate.

The receiver, which is shown on the right hand in figure 9, consisted like the transmitter, of a tinned-iron cylinder, closed at one end, and flattened on one side. Inside the cylinder, suitably supported on an upright stand, was placed an electro-magnet, with its poles in close proximity

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to the tinned-iron diaphragm. The above instruments successfully transmitted and reproduced articulate speech, but, as might be supposed, the resonance of the apparatus somewhat interfered with the distinctness of the articulation.

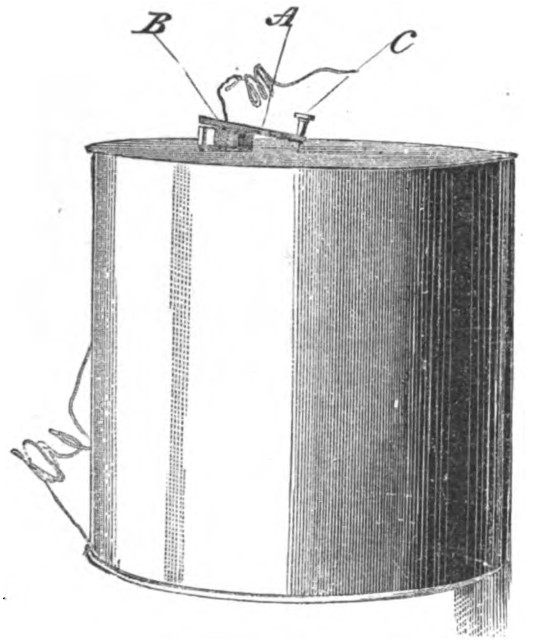

FIGURE 9.—McDonough's Tin-Drum Pendulum Transmitter.

A subsequent set of instruments known as "The brass-drum" instruments, are shown in figure 10.

A brass cylinder, A, has a membrane tightly stretched over one of its ends by means of the tightening ring, B, and the adjusting screws C. An adjusting screw and its socket-electrode are placed, as shown at the centre of the diaphragm. A wooden ring, G, is provided for supporting the tightening ring and diaphragm. The instruments rest on the under base, H. The hinged doors in the instruments are provided for the adjusting of an electro-magnet placed inside each drum, with its poles near a metal plate secured to the under side of the diaphragm. As in the previous instruments, various forms of electrodes were employed in connection with the adjusting screw. Since each of these instruments was provided with an electro-magnet, either could be employed alternately as transmitter and receiver.

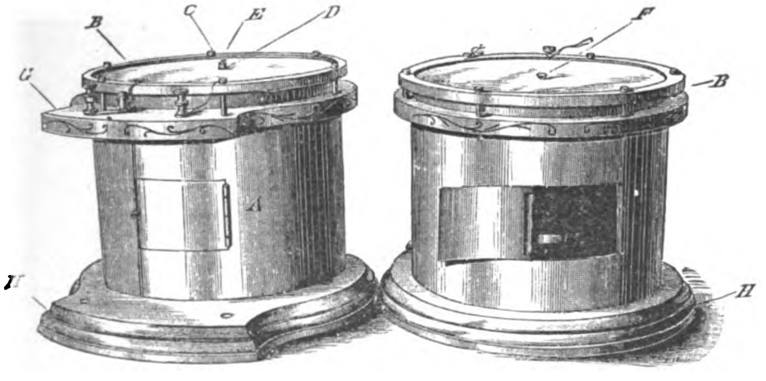

FIGURE 10.—McDonough's Brass-Drum Telephone.

Having thus briefly traced the progress of the invention as claimed by McDonough, and testified to by competent witnesses, we will now discuss the apparatus which was described, and figured in connection with his application in the United States Patent Office, on the 10th of April, 1876, together with the working model that accompanied said specification. The drawings that accompanied this specification are shown in figure 11.

"In figure 1," is shown a perspective view of the "teleloge."

"Figure 2," represents a section taken on the line *xx*.

"Figure 3," represents a vertical transverse section taken on the line *yy*.

"Figure 4," is a general top view of the same.

Quoting the language of the specification: "The object of my invention is to provide a means for transmitting articulate sounds from one place to another, through the medium of electricity, and it consists in the combination with an electrical battery, circuit wires, armature, magnet, and circuit breaker, of a transmitting and a receiving membrane or sounding apparatus, so constructed as to vibrate in accord with the vibrations of articulate sound, and so arranged relative to the magnet and circuit-breaker that the vibrations of the transmitting membrane or apparatus, produced by articulate sounds, are transmitted by the electrical current to the receiving membrane or apparatus, and so as to cause a like vibration of the receiving membrane or apparatus, and to cause it to reproduce the articulate sounds transmitted from and by the transmitting membrane or apparatus. My invention also consists in the novel construction of the circuit breaker, as is hereinafter more fully described."

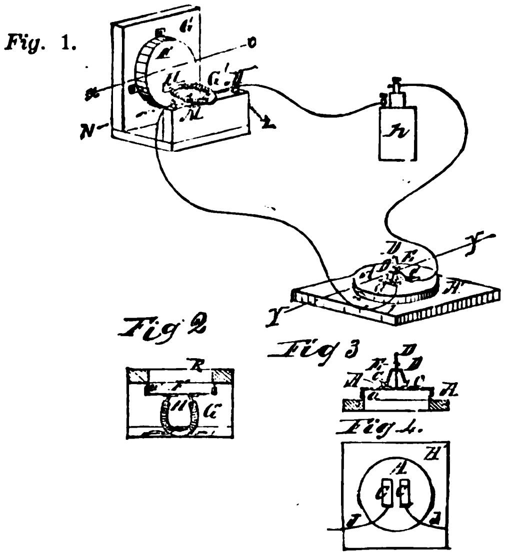

FIGURE 11.—McDonough's Drawings accompanying specification of Letters-Patent for a "Teleloge," filed April 10th, 1876.

Then follows a description of the drawing. The transmitting membrane or diaphragm, shown at A, is composed of vellum or other suitable material so stretched over a metal hoop, or ring, *a*, as to be capable of being tightened or loosened as desired. C, C, are two metal plates attached to the upper surface of the diaphragm, near its centre, in the relative positions shown, and are suitably insulated from each other. The metal bolt, D, permanently attached at its lower end to the centre of the diaphragm, between the two plates, and insulated from them, passes through an opening in the middle of the arch-shaped circuit-breaker, D′, and is furnished with an adjusting nut, F, that serves the purpose of limiting the movements of the circuit-breaker, D′. The circuit-breaker, D′, consists of an arch-shaped piece of metal loosely secured at its centre on the bolt D, and having its extremities bent upward at each end so as to provide contact-surfaces that rest on the metal plates C, C.

The receiving instrument consists of a diaphragm of vellum or other suitable material "sensitive to the vibrations of sound," stretched on a metal hoop or band a^1, in the position shown. An electro-magnet G^1, is placed with its poles opposite an armature, H, attached to the surface of the diaphragm.

The circuit connections are as follows: viz., one wire

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from the battery, *h*, is connected with one of the metal plates, C, and the other with one end of the coil of the electro-magnet of the receiving instrument. The other plate, C, is connected with the remaining terminal of the electro-magnet, G'.

The operation of the apparatus as described by the inventor is as follows, viz.: "The transmitting membrane, A, being sensitive to the vibrations of articulate sounds produced thereon, is caused to vibrate in sympathy therewith, thereby imparting an upward movement to the circuit-breaker at each vibration, disconnecting it from the plates, C, C, and alternately breaking and closing the circuit, when the intermittent current alternately magnetizes the magnet G', attracting the armature, H, and causes it, and the membrane, F, to vibrate simultaneously with the vibrations of the transmitting membrane, A, and in accord therewith, and so that the membrane, F, reproduces the articulate sounds transmitted from and by the membrane, A."

The working models accompanying this specification were destroyed in the fire at the Patent Office. A duplicate set of instruments was subsequently made and deposited in the Patent Office in lieu of those destroyed. Another set of duplicates was also made for examination and trial by experts. The details of these models are shown in figure 11.

We have already called attention to the fact that the above application was put in interference with Bell and the other applicants in the matter of the receiver only. This circumstance was due to the fact that the United States Patent Office held to the belief in the "undulatory current theory" as being essential to the transmission of articulate speech. It argued that speech could not be transmitted by make and break currents, and that since McDonough's apparatus described such currents it could not be considered as an articulating telephone transmitter. This singular process of reasoning, which was perhaps only the natural result of an unhesitating acceptance of a theory which can by no means be regarded as unquestionably proved, was maintained despite the fact that the model deposited in the office with the specification and drawings, together with the other apparatus we have described, could and did transmit intelligible, articulate speech, as has been amply testified by experts of unquestionable integrity and ability. No question, however, appears to have been raised as to the ability of the receiving instrument to reproduce sounds of all kinds, including intelligible, articulate speech, so that the Examiner of Interference awarded the priority of invention on this count of the interference to McDonough, above all the other contestants.

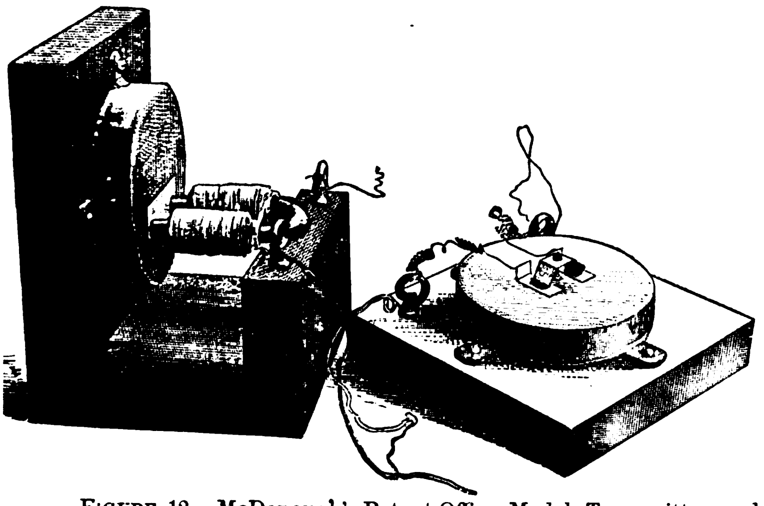

FIGURE 12.—McDonough's Patent Office Model, Transmitter and Receiver, April 10, 1875.

The subject-matter of the interference in case G, on Gray's claim, application of October 29, 1877, is as follows, viz.: "A telephonic receiver consisting of the combination in an electric circuit of a magnet and a diaphragm supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality.

"In the printed record containing the decision of the Examiner of Interferences it is acknowledged that a diversity of opinion exists as to the scope of this claim, and the interference founded thereon. It is claimed, on the one side, the designation, 'A Telephonic Receiver,' together with its prescribed capacity, 'whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality,' is tantamount to a claim for the combination of such receiver with an instrument capable of producing electrical waves or undulations bearing the impress of sound waves.

"On the other hand, it is maintained that the claim is to a described combination of these elements; an electric circuit, a magnet, and a diaphragm; the parts being so disposed and arranged as to manifest, among other functions, the capacity to reproduce sonorous vibrations electrically transmitted, and that the particular means for creating the electric current which is to be translated into sound-vibrations form no limitation upon the invention."

The Examiner-in-Interferences adopted the view that the issue embraced the telephone receiver alone, and on this construction of the issue awarded the priority of invention to McDonough. The Examiners-in-Chief, however, to whom, as we have already remarked the case was appealed, adopted the view that the issue clearly necessitated the combination with the receiver of a transmitter capable of throwing on the line the peculiarities of articulate speech. On the assumption that a transmitter constructed as was that of McDonough's could not transmit articulate speech, and that therefore the combination of such a transmitter with a diaphragm receiver was not effected, the Examiners-in-Chief, awarded the priority of invention to Bell. The above, as we have already remarked, was the natural conclusion, in view of the belief of the Examiners-in-Chief, as to the necessity for an undulatory current for the transmission of articulate speech.

There appears to be ample testimony by the most able experts that apparatus constructed in accordance with the McDonough specification of April 10, 1876, can and does clearly transmit intelligible articulate speech. McDonough's apparatus combines with a magnetic diaphragm receiver, what may, perhaps, be regarded as a variety of Reis transmitter. If then it be admitted that the Reis transmitter had never previously transmitted intelligible articulate speech, which we deny, then since it does transmit it when coupled with a magnetic diaphragm receiver, it might appear that the essence of the invention of the articulating telephone consisted in the invention of a suitable receiver to be used in combination with a Reis transmitter.

No little probability would appear to be given to this view, from the generally acknowledged fact that Reis transmitters operate very satisfactorily when combined with magnetic diaphragm receivers.

It is, indeed, in our opinion, an open question whether the real improvement in the art that placed the telephone as left by Reis in the extensive commercial use it now has, did not in reality consist rather in the invention of a more suitable receiver than it did in any modification the Reis transmitter has since received. We can readily understand how a current, modified by the action of the human voice on a Reis transmitter, would produce in a magnetic diaphragm such undulations in its magnetic field as would result in the movements necessary to reproduce the articulate speech thrown on the transmitter.

Such a view, it will be seen, takes the assumed necessity for the undulatory character, in the somewhat narrow sense in which it is generally construed, from the electric current transmitted, and places it in the transmitting and receiving diaphragms, so that the movements of the re-

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ceiving diaphragm would still be an exact reproduction of those of the transmitting diaphragm.

When describing the inventions of Reis, we will discuss at greater length the peculiarities of the electrical currents transmitted in telephony.

CENTRAL HIGH SCHOOL,
PHILADELPHIA, February 14, 1885.

ABSTRACTS AND EXTRACTS.

TEST OF THE EDISON-HOPKINSON DYNAMO.

Messrs. Mather and Platt, of Salford, have furnished to *Engineering*, the following account of a prolonged and practical trial of an Edison-Hopkinson dynamo constructed by them and designed to give a current of 250 amperès with an electromotive force of 55 volts.

DESCRIPTION OF MACHINE.

The dynamo is of the latest Edison-Hopkinson type with a short armature. The exterior dimensions are, length, 56 in.; breadth, 36 in.; and height, 60 in.; and the net weight of the machine complete is 32 cwt.

The commutator is of copper with mica insulation, and has 40 bars; and is provided with double brushes independently adjustable. The magnets are shunt-wound.

	Ohms.
The magnet resistance is	7.54
The armature resistance is	0.009

The dynamo is designed for a continuous load of 250 amperès, and 55 volts, and to run at a speed of 900 revolutions per minute.

The efficiency of the machine is deduced from the following figures :—

	Watts	Horse-power
Total electrical power developed	16,246	21.78
Loss in magnets	401	0.54
" armature	720	0.96
Power available in outer circuit when run as in test	15,125	20.28

Hence,

	Per Cent.
Electrical Efficiency	93.1
Loss in magnets	2.4
" armature	4.5

The following are particulars of the test to which this machine has been subjected :

The dynamo was arranged for driving by an ordinary strap from a double cylinder engine made by Mather and Platt, and carried on slide rails to admit of the belt being tightened if required. One of Sir William Thomson's graded potential galvanometers was permanently coupled to the machine to give a continuous indication of the electromotive force between the terminals, and arrangements were made for measuring the current by means of a current galvanometer also of Sir William Thomson's graded type.

The temperatures of the bearings were measured throughout the test by means of thermometers placed in mercury cups attached to the bearings, and a continuous record was kept of the temperature of the room.

The speed was indicated by a tachometer attached to the engine, and the revolutions of the dynamo counted from time to time with a counter.

The load was maintained constant throughout the test, as nearly as possible at 275 amperès, and 55 volts, measured at the terminals. This is 10 per cent. above the normal load for which the machine is intended.

The machine was started on December 30th, and run for five hours, when the temperatures were taken as follows :

Room, 17 deg. C.; pulley bearing, 35 deg. C.; commutator bearing, 36 deg. C.; magnets, 33 deg. C.; armature, 76 deg. C.; commutator, 70 deg. C.

At the end of 12 hours run the temperatures were again taken :

Room, 20 deg. C.; pulley bearing, 36 deg. C.; commutator bearing, 34 deg. C.; magnets, 33 deg. C.; armature, 84 deg. C.; commutator, 75 deg. C.

Again at the end of 24 hours the temperatures were : Room, 15 deg. C.; pulley bearing, 30 deg. C.; commutator bearing, 29 deg. C.; magnets, 33 deg. C.; armature, 76 deg. C.; commutator, 74 deg. C.; Showing that at the end of 12 hours the maximum temperatures had been reached in all parts of the machine. Subsequently, throughout the entire run of three weeks' duration, the temperatures did not vary more than was accounted for by variations in the temperature of the room.

The speed maintained throughout the run varied from 910 to 925 revolutions, with the full load, and the armature and magnets warm.

The machine was run continuously, stopping ten minutes daily to read the temperatures of the armature and commutator, and for Sunday, until January 6th, when it was stopped in order to take out the armature and have it examined to determine if there were any sign of charring or deterioration in the insulation of the wire ; and in order carefully to examine the commutator. The examination was conducted by Mr. Blackburn on behalf of the Edison and Swan United company, and no change whatever was observable either in the insulation of the wires of the armature or in the commutator.

It was then decided to run the machine absolutely continuously for a fortnight without any break whatever, with the full load of 275 amperès. This test concluded on January 20th.

Throughout the whole of this continuous run for 14 days there was never the slightest sparking at the commutator, the bearings and magnets remained at a uniform temperature throughout, and the temperature of the commutator at the end of the run was 79 deg. C., practically the same temperature as at the end of 12 hours. One set of brushes were used without change of adjustment for 12 days, and at the end were found to be worn down uniformly 1-16 in.

The commutator was perfectly smooth, and showed no signs of wear or grooving, and the armature had stood the run without the slightest swelling or any sign whatever of change in the insulation.

These tests were undertaken by Mather and Platt at the request of the Edison and Swan company, in order to show the durability of the Edison-Hopkinson dynamo under a long and continuous strain with a load of 10 per cent. in excess of that for which the machine is sold. The conditions of the test were formulated by Mr. Albright and Mr. Blackburn on behalf of the Edison and Swan company, and it was superintended by them and their representative, Mr. Creagh, during the entire run.

It proved conclusively that a dynamo of this type may be run continuously without any change in its working parts or deterioration in the insulation of the copper conductors or change in their resistance, and that the wear is exclusively confined to the commutator and copper brushes, and that, with regard to the former, three weeks' run is not sufficient to produce any visible wear, and that the brushes last much longer than is usually supposed, one set being capable of lasting a year on a machine running on an average three hours a day.

ELECTRIC LIGHTING IN AMERICA.[1]

No part of the expert evidence submitted to the Parliamentary Committee impressed the members of the committee more strongly than that elicited from American witnesses. The lucid and confident manner in which the cost of lighting a square mile of London at a little under $485,000 was set forth, gave a high idea of the extent and success of transatlantic achievements in electric illumination. Not for the first time, John Bull was deceived, not

1.—This article from the London *Statist*, Nov. 15, 1884, has been frequently referred to in America. By request we publish it in full, substituting the decimal for sterling denomination.

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only as to the actual facts relating to the condition of things electrical in English cities, but also as to the state of affairs across the Atlantic. Facts were either misrepresented or withheld.

We have lately had the opportunity of examining, from unimpeachable sources, the cost and revenue of the only electric-light station in the world which has seriously undertaken the task of competition with gas. We propose, therefore, to give our readers a brief history of this station from its foundation two years ago, with the financial results at the present time. Financially supported by the firm of Drexel, Morgan and Co. and many of their clients and supporters—to the exclusion, however, of Messrs. J. S. Morgan and Co., who from the first declined any financial connection with the concern—Mr. Edison opened in New York, in September, 1882, the First District Illuminating Station. This portion of the empire city is the most densely populated part of the business or "down town" quarter. The area lighted is contained in a square of 2,400 feet, and has, therefore, an area of something less than a quarter of a square mile. The district contains about 50 blocks of buildings, and is intersected by some 15 streets or passages. The necessary permission to open the streets to lay the electric mains was obtained, not by Act of Congress or by other legislative or official means, but by the simpler and perhaps less costly method of a payment to Tammany. The sum which passed amounted to about $48,500, and in exchange for this payment the Edison company is free to tear about the streets whenever it pleases it so to do for electric lighting purposes. On September 4th, 1882, the station was started with 2,323 lamps, contained in about 85 houses. These lamps have increased in number until last month 12,540 lamps had been installed, the present capacity of the station being now attained. The largest number of lamps ever burning at one time was 5,530 in January of this year, and their average life, based on about 12,000 renewals, is a little more than 400 hours. Shortly after the installation of the station, it was found that some customers did not require the light in the summer, and that consequently their custom involved loss. It became necessary, therefore, to cull from among the customers those whose demand was less than an average of 2¾ hours per day for every lamp connected on their premises. If their consumption fell short of this standard, they were quietly got rid of, so that the actual average consumption of light per lamp was artificially raised above the normal gas average of the district. This process of natural selection in New York is important, because, under the English Act, a customer using but half an hour's light in a month can not only claim to be supplied, but must, under grave penalties, be supplied by the unhappy company. During the first year little money was received from customers, partly owing to the novelty of the enterprise, and partly owing to a natural desire on the part of the management that criticism should be disarmed before claims were lodged for the amount of the lighting bills. The cost of gas in the First District of New York is about $2.25 per 1,000 cubic feet. Competition, therefore, with the elder illuminant, having regard to the power of picking the good customers, and of unreserved access to the streets, was rendered distinctly favorable. Added to this was the fact of Mr. Edison's presence, and the supply of ample funds for the purposes of the momentous experiment. These favorable elements notwithstanding, the financial result, when viewed from an impartial standpoint, is not only disappointing, but absolutely and finally disposes of any idea that electric lighting in England contains the germs of remunerative investment. Before giving the figures of the capital investment, running expenses, and revenue, it must be premised that the management of the station has been—at any rate during the period over which the returns in our possession extend—able, economical, and efficient. Not only is American genius more suited to the *exploitation* of new industrial developments than that of older countries, but there is a general disposition to help along a new scientific undertaking, which is signally wanting in England. The cost of the station is somewhat in excess of $970,000, and the annual expenditure is at the rate of nearly $77,600 a year, without allowing for depreciation, sinking fund, or interest on capital. The excess of receipts over actual cash outlay amount to about $29,100 a year, or 3 per cent. on the capital invested. When, however, a due allowance is made for unforeseen contingencies, such as the bursting of a boiler or other heavy casualties, it will be seen that the alleged profit is illusory, and if, at most, expenditure is equal to revenue, it is certainly not less. In order to appreciate the precise nature of the result of this experiment, it is necessary to suppose that each glow lamp is replaced by a five-foot gas-burner, and that the amount of gas consumed to produce an equivalent of light be computed. The result of this calculation gives $1.73 as the cost per 1,000 feet of the gas thus consumed. If, however, a 16-candle lamp be held to compete with a seven-foot gas jet, then the equivalent is as nearly as may be $1.21 per 1,000 cubic feet. To compete with gas at 73c, the cost of maintenance—*i. e.*, of production—must be reduced by two-thirds. On examining the means of reducing the cost of establishment, there is no reason to doubt that an equally efficient plant could be laid down in England for half the sum expended in New York; but it is improbable that the cost of maintenance can be seriously diminished. From the foregoing, it is clear that such stations as the Victoria and Holborn installations, established by the Swan and Edison companies respectively, or the Colchester experiment of the South-Eastern (Brush) company, must inevitably lead to a permanent consumption of the available resources of the companies in question. Finally, we are driven to the conclusion that, so far as central station lighting is concerned, the prospects in England are hopeless until a radical improvement in principle has been effected; and boards of directors maintaining the contrary, in the face of the experience gained on both sides of the Atlantic, incur a responsibility which, for our part, we are disinclined to share.

PLATINUM AND ITS PECULIARITIES.

The fact that nearly every description of electrical apparatus embraces, among the materials used in its construction, a certain amount of platinum, has made the name and appearance of this metal familiar to the merest tyro in electrical science. Its origin and some of its peculiar characteristics are, however, not so generally known, but will be found of interest to those who desire to become familiar with the various branches of industry indirectly connected with their avocation.

The platinum business of the United States is in the hands of a few firms, and the demand for the metal is now so brisk that it is with difficulty that sufficient quantities of it are obtained. Nearly the entire supply comes from the celebrated mines of the Demidoff family, who enjoy a monopoly of its production in Russia. The raw material, as it arrives in this country, is already refined, and formed into sheets of various grades of thickness, also into different sizes of wire. In order to meet the requirements of our mechanics, however, it is frequently necessary to change these sizes, which is readily effected by the ordinary processes of rolling or drawing. At one time Russian coins were made from the metal, but it is no longer used for this purpose. Limited quantities of platinum ore have been brought from South American mines, and successfully refined. As yet it has been found only in Colombia; but the mineral regions of South America have not as yet been thoroughly examined, and it may eventually be found in other states. It also exists in the remoter portions of British Columbia, near the sources of the Peace River, and samples found in Montana have been tested in New York.

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There is a popular supposition that it ranks with gold in intrinsic value. It did at one time nearly reach that point, but it is now worth from $8 to $12 per ounce, according to the form in which it is required, or the amount of alloy it contains. Iridium is used as its alloy, which hardens it, and renders it more difficult to work. Pure platinum is as soft as silver, but by the addition of iridium it becomes the hardest of metals. Its infusibility is the most serious obstacle to its manipulation. A temperature which will melt any ordinary metal has not the slightest effect upon it. If we place a platinum wire, no larger than a hair, in a furnace where ingots of steel are being melted all around it, it will come out absolutely unchanged. The melting temperature of platinum alone, has not been accurately determined, yet singularly enough, if a piece of lead be placed in the crucible with the platinum, both metals will melt together, at the comparatively low temperature at which lead becomes fluid. If a piece of lead be melted in a platinum crucible, as soon as the lead melts the platinum follows, and the crucible is destroyed.

Among other peculiar characteristics of platinum is its extreme ductility. A wire can be drawn from it to a smaller diameter than from any other known metal; in fact, so thin as to be invisible to the naked eye, which renders it useful for cross wires in optical instruments. Draw-plates for the ordinary finer sizes of wire are formed of rubies and sapphires. The process of drilling such small holes in these hard stones, is a very delicate one, and is esteemed a trade secret. Still more delicate, perhaps, is the filing down to a long tapering point, the end of a wire $\frac{1}{1800}$ of an inch in diameter, so that it may be passed through a draw-plate, which will reduce its size still more, it being then started by catching the end with a pair of nippers. This fine wire is used also for surgical purposes, in which it is heated to incandescence by an electric current, searing the flesh as it cuts, thus preventing the loss of blood, the operation being also painless.

The precious stones for draw-plates are prepared by a Swiss lady in New York city, who has followed the business for over 30 years. It was a very lucrative trade at a time when filigree gold jewelry was in fashion. The plates were then worth from $2.50 to $15, according to size. The stones used are not the most finely colored, but they must be free from flaws. These are cut by a lapidary into small discs, after which the hole is drilled through by hand—funnel shaped, and barely perceptible at its smallest point. It must be perfectly smooth, and of an accurate gauge. When finished, such draw-plates, if carefully used, are practically indestructible.

Many attempts have been made to find an efficient substitute for platinum, for the contact points of electrical apparatus, but with at least only partial success. The consumption of platinum for the terminals of incandescent electric lamps is already becoming an important item, and bids fair to increase almost indefinitely.

THE TELEPHONIC TELEGRAPH.

The Toronto *Globe* of February 13, gives the following description of the test of a recent Canadian invention. Yesterday afternoon at about six o'clock a test was made at the office of the G. N. W. Telegraph Co. in this city of the recent invention of Dr. A. M. Rosebrugh and Mr. G. Black, of Hamilton, by means of which telephonic and telegraphic messages can be exchanged through long distances on the same wire simultaneously. A member of the *Globe* staff held a conversation with the *Globe* correspondent in Hamilton, the voice of the one being distinctly recognizable by the other even when dropped to a whisper that was inaudible to a person a few feet away from the whisperer. While the telephone messages were being exchanged, Mr. Toye, of the G. N. W. company, sent from his end on the same line a telegraphic message, which was immediately repeated by telephone from the Hamilton end. The main virtue of the invention consists in the entire suppression of the induction, which is such a nuisance on the ordinary telephone. For instance, everybody who has occasion to use the telephone in Toronto after nightfall knows that the noise caused by induction from the electric light wires is such, on wet nights especially, as almost to render conversation inaudible. Dr. Rosebrugh illustrated his invention by disconnecting the telephone instrument for a few moments from the appliance which suppresses the induction. Straightway the familiar buzz of the electric light company's dynamo was heard. Restoring the connection, the noise from the dynamo ceased to trouble. When the telegraphic signals were being sent over the line there was no inconvenience whatever felt by the listeners. The wire used for the test was one which passes from the G. N. W. Telegraph Co.'s office up Church street and Queen along through a perfect maze of telegraph wires, and for two miles on the same poles with the electric light wires.

THE CHINESE ACOUSTIC TELEPHONE AND PHONOGRAPH.

At the last meeting of the China Asiatic Society at Shanghai an instrument, which was a species of primitive telephone, was presented for inspection by Dr. Macgowan, of Wenchow. It consisted of two bamboo cylinders, from one and one-half to two inches in diameter and four inches in length; one end of each was closed by a tympanum of pig bladder, which was perforated for the transmitting string, the latter being kept in place by being knotted. This rude instrument is called the "listening tubes," and is employed for amusement as a toy, conveying whispers 40 to 50 feet. It is unknown in many parts of China, the provinces of Che-kiang and Kiangsu being the only ones, so far as can be ascertained, where the listening tubes are employed. Besides this toy, Chinese ingenuity produced, about a century and a half ago, the "thousand mile speaker." This instrument is described as "a roll of copper, likened to a pipe, containing an artificial device; whispered into, and immediately closed, the confined message, however long, may be conveyed to any distance, and thus, in a battle, recent instructions may be conveniently communicated. It is a contrivance of extraordinary merit." The inventor of the "thousand-mile speaker," one Chiang Shun-hsin, of Huichou, flourished during the reign of Kang-hsi, during parts of the 17th and 18th centuries. He wrote on occult science, astronomy, and foreign physics, and the above description of his invention was copied from his works into a provincial encyclopædia. At the time the latter work was published—in the reign of Kien Long—there was no longer an instrument of this kind in the province, as the ingenious invention appears to have perished with the student who contrived it.—*Nature.*

THE ELECTRO-CHEMICAL EQUIVALENT OF SILVER.

A very careful and important determination of the electro-chemical equivalent of silver has been made at the Observatory of the Physical Institute of Wurzburg, and the results are that an ampère current following for one second, or one coulomb of electricity, deposits 1.1188 milligrammes of silver or 0.3281 milligrammes of copper, and decomposes 0.09328 milligrammes of water, a result agreeing closely with that of Lord Rayleigh, recently communicated to the Physical Society. An ampère therefore deposits 4.0259 grams of silver per hour; Kohlrausch's value is 4.0824, which has hitherto been universally accepted. This value is so useful in accurate measurements that it is eminently satisfactory to find the new determination agreeing so closely with that of Lord Rayleigh, which will probably be adopted by English electricians.

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LITERATURE.

REVIEWS.

Dynamo-Electric Machinery; a Manual for Students of Electrotechnics. By SILVANUS P. THOMPSON, B. A., D. Sc. E. & F. N. Spon, London and New York, 1884.

In the autumn of 1882, Professor Thompson delivered a series of lectures before the Society of Arts in London, on dynamo-electric machinery. These lectures were soon afterwards published in the Journal of the Society, and were subsequently reproduced in several European technical journals, and also in pamphlet form. Every student and investigator of dynamo-electric machinery into whose hands these lectures came was at once impressed with the originality, the completeness and the great practical value of Professor Thompson's labors. The subject was at that time but imperfectly understood, even by otherwise well informed electricians. The diverse forms in which the machine had already been embodied by the ingenuity of numerous inventors were so numerous as to defy satisfactory classification, while the application of any general method of mathematical investigation seemed to be almost an impossibility. The method of treatment which was adopted by Professor Thompson was radically different from that of any of his predecessors. His happily conceived plan of logically grouping the various dynamos in connection with certain typical and characteristic forms was executed in a manner which exhibited an unusual grasp of mind and power of analysis. The practical value of such a system of classification is due to the fact that these type forms are fixed in the mind with little effort, and may be at once recognized when appearing in any disguise, thus enabling each new machine which may hereafter appear to be referred to its characteristic type, rendering its comparison with others a matter of comparatively little difficulty.

These lectures were republished in the United States and a French translation also appeared in Paris; the wide circulation thus given to them indicated that they supplied a recognized want, and the author was thus led to prepare the present volume, which although based upon the original lectures is by no means a mere reprint of them. A considerable amount of matter has been added to the original chapters, so that they now contain descriptions of most of the recent inventions of importance. Many other forms of machines, of merely historical interest and obsolete in practice have wisely been omitted. A careful analysis of this treatise upon which an adequate review of its contents could be based, would be a work of much time and labor. We have, however, examined the volume with as much thoroughness as possible in view of the limited time at our disposal, and will call attention to such points as have suggested themselves to us.

In the preface the author observes that "there is no such thing yet as a best dynamo," but that like a voltaic battery some are best adapted to one use and some to another. This comparison is a mistaken one. It can hardly be disputed that the best dynamo for all purposes must be the one which is most "efficient;" which with a given speed, will produce the greatest E. M. F. with the least internal resistance. Experience certainly shows that the dynamo, which when wound for high E. M. F. makes the most efficient arc-light machine, when wound for low E. M. F. will make the most efficient electro-plating machine; that is to say, other things being equal, the best machine for *all* purposes is that, which with a given consumption of h. p. will develop the greatest C E and this proportion must necessarily hold good irrespective of the relative values of C and E.

The fundamental classification of dynamos proposed in chapter ii., while unquestionably a radical improvement upon those based upon arbitrary and unmeaning distinctions, is not altogether satisfactory. While it is by no means easy to suggest a classification more satisfactory than that of Professor Thompson, which is based entirely upon the characteristics of the magnetic field, yet even this is open to the objection that it necessarily relegates the armature, really the most important part of the machine, to a secondary classification, while some few typical dynamos can be assigned no place within it.

A complete exposition of all the known principles involved in action of the dynamo is given in chapter iii, and the best theoretical and practical forms to be given to the machines are discussed at length, even the smaller details of construction receiving careful consideration. There is much in this chapter which may be studied with great advantage by the designers of dynamo machines. We find however some instances in which it might be wished that the language of the author had been more explicit. For example he says (p. 31) that "there ought to be so much iron in the armature core, that it is magnetized just up to the critical degree of saturation when the machine is generating its maximum current." This is one of the most important points in the construction of the machine, but are we to understand that the armature shall be so magnetized by its own coils, or by the inductive action of the field, or by the difference between these two in favor of the field? Again, is it not the essential function of the armature core to provide such a path for the lines of force that the portion of the field cut by the armature wires may possess the highest possible intensity, and if this is the case, why should not the core be made as large as possible? Some of the statements made in this chapter present an apparent contradiction in terms which the student will find somewhat puzzling. For example (p. 28) the Maxim armature is criticised as having a great quantity of idle wire on its inner surface, and the author then goes on to say in the same breath that the "very excellent machine" of Crompton and Kapp has an armature of the same kind. Again, on p. 38, the author objects to the consequent-pole field as exemplified in the Siemens and Weston machines, which he compares unfavorably with the double magnet used in Deprez's double Gramme dynamo, although the application of that system of field magnets to a single armature machine is not obvious.

In view of the repeated references to the Jürgensen dynamo it would have been well to have included a description of it, but, doubtless by an oversight, the author has omitted to do so.

In chapter iv, a large number of original, interesting and instructive experiments are described, having to do with the induction of electric currents and the distribution of potential in the armature. This portion of the work will repay careful study, and the same may be said of chapter v. The discussion in the last named chapter of the reactions in the armature and in the magnetic field is particularly good. The statements are clear, well-presented and convincing.

In chapter vi, in which is discussed the government of dynamos and the different methods of exciting and maintaining the magnetic field, we find some statements which to say the least appear to be misleading. On page 86 it is said that any of the different methods for maintaining the field may, be applied either in direct-current or in alternate-current machines. It is not easy to see how the "series" system, for example, can be applied to an alternate-current machine, neither can we imagine how the "shunt" system can be applied to it, without commuting the current, or at least a part of it, which would convert the dynamo, either wholly or partially, into a direct-current machine. On page 87 it is stated that if the armature of a "series" dynamo "had no resistance at all, then the current furnished to the system of lamps (in multiple arc) when the armature speed is constant, would be exactly proportional to the resistance of the external circuit." The author evidently intended to say "directly proportional to the number of lamps" or "inversely to the circuit resistance." But is the statement true even with this limitation? Even if a direct-circuit machine had no resistance in its armature, diminishing the external resistance would necessarily increase the current, and this stronger current would flow through the magnet and strengthen the field, thereby increasing the E. M. F. On the other hand if the armature had a sensible resistance, the potential at the terminals of the machine would be reduced when the external resistance was decreased, and this, by neutralizing the augmented E. M. F., due to the stronger field, might aid in maintaining a constant potential at the binding-posts. The very type of machine —the Weston—which it is said in a foot-note, most nearly fulfills this condition, is, as a matter of fact, "shunt" wound.

In continuation of the same subject it is further said, "on the other hand if a shunt-dynamo were constructed with an armature of considerable resistance, the E. M. F. which it would develop at a constant speed would be nearly proportional to the external resistance, for doubling the external resistance would very nearly double the current thrown round the shunt." Possibly an armature might be constructed of such a resistance that this would be the case, but it would necessarily have to be of detrimentally high resistance, and in any case the statement is not true as a general proposition. We think that all practical electric light engineers will agree with us that Professor Thompson is entirely mistaken in the idea which he puts forth with so much apparent confidence, that the shunt-winding is only suitable for a constant current. When the problem is that of the maintenance of a constant E. M. F. with a varying current, as when incandescent lamps are burned in multiple arc, shunt winding is even more effective. If we start with the author's own assumption that the armature is driven at a uniform speed and its resistance is inappreciable, the volume of current must nevertheless vary directly as the number of lamps, and inasmuch as a varying external resistance does not alter the potential at the terminals of the machine, the field must remain constant, and it is obvious that with a constant speed and a constant intensity of field the E. M. F. must also be constant. The practical operation of the machine before cited (Weston's) demonstrates the correctness of this view. We are aware, of course, that if the field were weak so that the current in the armature could react upon it, this would not be strictly true. The fundamental error which Professor Thompson has here fallen into, obviously arises from conviction that a dynamo must of necessity have a sensible armature resistance. On page 90 the "series and magneto" system of Professor Perry, is described—if not with approval—at least without criticism. This system is intended to provide a constant E. M. F., to do which it requires an independent auxilliary magneto-machine with an E. M. F. equal to that required by the lamps, and being in the main circuit this must carry the entire working current. It strikes us that it would not have been out of place for the author to have pointed out the

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patent absurdity of this organization from a practical point of view.

A good deal might be said in relation to the contents of chapter vi. The author bestows a liberal measure of approbation upon the Crompton-Kapp machine, which may for aught we know be abundantly justified, but it is certain that the reasons given therefor are by no means convincing. Thus it is stated (page 113) that by reason of the great strength of the field there is but little lead to the brushes, and "*what lead there is is absolutely constant.*" Now whatever lead there is, must be due to no other cause than the reaction of the current in the armature, hence if this current is very greatly reduced, as for example by cutting out nearly all the lamps, we fail to understand why this would not necessitate an alteration in the lead. A great deal of space is devoted to the Victoria dynamo, much more than to any other machine. The warm commendation bestowed upon this particular machine may perhaps be taken with a grain of allowance, as we understand that the author took a very active part in its reorganization. Chapters vii, viii and ix contain excellent descriptions of most of the machines actually in use, embracing all the essential types. The analysis and description of the Brush machine—an invention which has fared very badly at the hands of many who have attempted to describe it—is particularly good. We observe that the author has failed to comprehend some of the peculiarities of the Weston machine, as for example, he states (p. 147) that the method of winding the armature with two circuits was adopted in order that an accident to one section should not completely break down the machine. The real reason is to prevent the armature coils from being burned by the accidental short-circuiting of two adjacent sections of the commutator. Two distinct sets of coils alternate throughout the circumference of the armature, which are connected to alternate plates of the commutator in a manner fully described and illustrated on page 240 volume i. of the *Electrician*, now the ELECTRICIAN AND ELECTRICAL ENGINEER. It is also asserted that the Weston incandescent machine is self-regulating simply because its internal resistance is *nil*. While it is true that this circumstance is an important factor in the production of the result aimed at, many other changes in the form and proportion of the machine were found necessary to its successful accomplishment. It was found to be especially important that the inductive influence of the field-magnets, by which the polarity of the armature core is principally determined, shall so greatly preponderate over the magnetic influence of the current in the armature coil as to wholly overcome its effect. By this means the polar line of the armature is brought into close coincidence with the corresponding line of the field, thus causing the actual points of maximum potential upon the commutator to correspond with the theoretical points. This has been done with so much success that the machine may actually be run in either direction without altering the position of the brushes.

Chapters x to xvii treat of the mathematical and geometrical theory of the dynamo. We must leave the discussion of this portion of the work to more competent hands. The author himself, in his preface, says :—

> The true mathematical theory of the dynamo can only be written when the true basis for writing it shall have been discovered. That basis, the exact law of induction of magnetism in the electro-magnet, does not yet exist.........Our coefficients of magnetic permeability and magnetic susceptibility, though convenient as symbols, are little more than convenient methods of expressing our ignorance. We want some new philosopher to do for the magnetic circuit what Dr. Ohm did for the voltaic circuit fifty years ago. Until we know the true law of the electro-magnet there can be no true or complete theory of the dynamo.

Chapters xviii to xxv are devoted to a discussion at length of the dynamo as a motor, and various special forms of motors are described.

The author does not profess to enter into the historical aspect of the subject, although an occasional allusion of this kind may be found, in respect to which the criticism might be made that the author has failed to inform himself as thoroughly as he might have done, of the by no means unimportant work which has been done in the United States in the development of the dynamo-electric machine and the electric motor.

The mechanical execution of the book, with the exception of the binding, is of the best character. The illustrations are original, and are illustrative. They have been introduced with great liberality wherever they could add to the clearness of an explanation, and we are glad to see that the author has not hesitated to repeat one, whenever necessary, rather than to put the reader to the annoyance of turning to another part of the book.

Future editions will no doubt greatly improve this already excellent work, and we have no doubt that it will hold its place as a standard authority on this branch of electrotechnics for many years to come.

A Pocket-book of Electrical Rules and Tables for the use of Electricians and Engineers. By JOHN MUNRO and ANDREW JAMIESON. London. Charles Griffin & Co., 1884.

The Electrician's Pocket-book. Being the English Edition of Hospitalier's "*Formulaire Pratique de l'Electricien.* Translated, with additions by GORDON WIGAN, M.A. Cassell & Company, Limited. London, Paris and New York, 1884.

As long ago as 1871 Messrs. Latimer Clark and Robert Sabine published their well known *Electrical Tables and Formulæ*, a work of great merit, which speedily found its way into the hands of the electricians and telegraphic engineers of both hemispheres. At that date the electrician's field of labor was comparatively a limited one, and outside of the departments of land and submarine telegraphy, can hardly be said to have had a recognized existence. It was not until a comparatively recent period that the need of a little more comprehensive work of the kind began to be seriously felt. The extensive practical application of the dynamo-electric machine in electro-plating, electric illumination, the transmission of power and even in telegraphy, has brought about an entirely different order of things from that which existed in former years. The electrician is now called upon to deal with currents of enormous volume and potential, and although it is true that these are governed by the same universal laws, the methods of dealing with them and the instruments and apparatus which it is necessary to employ for the purpose, are wholly different from those designed to cope with the comparatively feeble electric forces of an earlier day. It is not surprising, therefore, that when Messrs. Munro and Jamieson published in the summer of 1884 the first edition of their Pocket-book, the demand for it was so great that the whole edition was exhausted within a few weeks, a fact which sufficiently evidences the demand which existed for a work of the kind. The value of such a compilation as this depends very largely upon the ability and practical knowledge of the author, and in this respect it would perhaps be difficult to find two persons better qualified for the task than the gentlemen who have undertaken it.

Speaking first of externals, we find that although the whole subject of electrical engineering has been well covered and a great amount of matter collected, yet by careful condensation and skilful typography the whole has been compressed into about 500 pages, making a book similar in size and style to Molesworth's well known Engineer's Pocket-book. In fact, by reason of the small size of the page and the thinness of the paper, it is considerably less bulky than the majority of books of this class.

A work of this kind does not admit of a lengthy review, and we will therefore content ourselves by giving a synopsis of the contents, which are as follows: Units of measurement, Measures, Testing, Conductors, Dielectrics, Submarine Cables, Telegraphy, Electro-Chemistry and Metallurgy, Batteries, Dynamos and Motors, Electric Lighting, Miscellaneous and Logarithms. It will be apparent from this list of subjects that the field has been pretty well covered. The best evidence of the real value of such a work, is the opinion founded upon the experience of those who have had occasion to use it. For our own part we can say that we have kept a copy within convenient reach from the time it first came into our hands, and have come to regard it as an indispensable companion, while a number of the most prominent electrical engineers of our acquaintance have cordially endorsed our opinion of it. There is no doubt much room for criticism, for everyone has his own private opinion as to the matter which ought to be retained and that which ought to be omitted in a work of this kind, but on this point the opinion of the authors is perhaps entitled to as much respect as that of anyone else. The principal fault in the work in our opinion is the excessive amount of theoretical matter which has been included. Many of the formulæ are far to complicated to be of any practical use, and might with great advantage have been replaced with tables covering the same ground. Some of the tables too, are not sufficiently full to answer the purpose, in the refinement of modern electrical work, such for instance as the tables of logarithms. Unless these are printed with serviceable fullness, it would have been as well to have omitted them altogether.

From its intrinsic value and its convenient and attractive form the book has already met with a success which must be alike gratifying to the authors and to the publishers, and we cannot doubt that it will continue to meet with the approbation which it so well deserves.

Two editions have been published of M. Hospitalier's original *Formulaire* in the French language, and we understand that it is proposed to continue it as an annual, with such revisions and additions as may be required from year to year. The present work is an English translation based on the second edition of the original. It is hardly proper to entitle it a pocket-book, which it certainly is not in the sense in which that term is ordinarily used by working engineers. It is true it is not a very large volume, but nevertheless we fancy it would be found somewhat difficult to crowd it into the ordinary professional pocket. On the other hand it is rather too small for convenient use on the table, and moreover it is bound in such a way that it will not stay open, which in a work of this character is an exasperating inconvenience. The contents of the book are in a general sense very much the same as that of Munro and Jamieson's but the treatment is in many respects quite different. The subject matter is divided into five parts; the first comprising definitions and general laws, the second, units of measurement, the third, instruments and methods of measure-

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ment, the fourth, formulæ applications and experimental results, including the production and the various applications of electricity in detail, while the fifth contains various recipes and processes. The material is very systematically arranged and a great number of tables are given. In fact, in the matter of useful tables and statistical information the work is of noteworthy value.

It is a matter of surprise to us that such a work as that of Mr. Wigan should be published without an index. This oversight greatly impairs its general usefulness. The French are incorrigible offenders in this respect, but we should have expected the translator or publisher to have supplied the omission. It is true that this is partially compensated for by the systematic arrangement of the subject-matter and an unusually full table of contents, supplemented by an index of the tables contained in the volume, but this nevertheless does not subserve the office of a topical index which enables anything required to be found in a moment, and we need hardly say that to the electrician who needs to consult a work of this kind moments are often very precious.

Were we asked to make a choice between these two collections of formulæ and tables, we should be compelled to say we would take them both, for each contains much material of value which is not to be found in the other.

Traité Pratique d'Electricité Industrielle. Par E. CADIAT and L. DUBOST. Paris: Baudry et Cie., 1885. (496 p., 204 illustrations, pr. 15 francs.)

This publication differs somewhat in character from the general run of works on electricity and its applications which have made their appearance in such numbers within the past few years. It embraces the more important industrial applications of electricity, other than the electric telegraph, and is intended rather to meet the wants of electrical constructors and practical men generally, than to enter largely into theoretical considerations, or, on the other hand, to attempt to interest the reader of what may be termed "popular-science literature." The plan of the work is excellent, and it has been carried out with intelligence and ability. The subject-matter is divided into six parts, treating respectively of the general principles of electric science, electric generators, mechanical and chemical, electric lighting, the transmission of force, electro-metallurgy and telephony.

The first part of the work presents an admirable resumé of the fundamental principles of electricity, the units of measurement and their relation to the mechanical units. The various methods of measurement of resistance, potential, current and capacity are well explained, and there are also the necessary instructions for dynamic and photometric determinations. In the second part the different forms of voltaic elements are discussed, together with the considerations upon which their relative value depends under different circumstances. There is little that is new to be found in the chapter on dynamo-electric machines, although the terse and clear manner in which the subject is presented deserves commendation. The storage battery problem is also discussed at some length. The portion of the work relating to arc and incandescent lighting is very properly confined quite closely to the systems which have thus far proved themselves efficient in practice. The results obtained by the Paris commission of 1881 are given in full. The chapter on the electric transmission of force, after having stated the nature and conditions of the problem to be solved, gives a history of the principal experiments which have been made from 1873 to the present time, especially those of Marcel Deprez. The computations of M. Beringer, giving in tabular form the comparative cost of transmitting energy to different distance by electricity, hydraulic pressure, compressed air and wire-ropes, are of much value. An interesting description is given of Fleming Jenkins' system of telpherage, which may not improbably turn out to be one of the most important inventions of the century, in the way of transportation. The chapter on electro-metallurgy though necessarily brief, is perhaps all that could be expected in a work of this kind. The concluding chapter on the telephone is simply a description of the construction and mode of operation of the existing telephone systems in France, and contains little that is new or useful to the well-informed practical electrician. In fact the subject of telephony would seem to be hardly a proper one to be included within the scope of the work.

Like most modern French scientific treatises, the book is handsomely printed and profusely illustrated with engravings, largely from original designs.

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QUESTIONS AND ANSWERS.

[59.] **Correction—Dynamic Units.**—A typographical error in our last issue made nonsense of our reply to G. N. V., of Linden, N. J. What we intended to say was this :—"The unit of work is called the *erg*. It is the amount of work done by one *dyne* working through the distance of one *centimetre*, the dyne being the force which, acting upon one gramme for one second, generates a velocity of one centimetre per second.

[60.] **Electric Motor.**—L. T. W., Brooklyn, E. D., has made a motor in accordance with the directions given in the ELECTRICAL ENGINEER, and has wound it with No. 20 wire. He writes that he can get no result with four cells of Eagles' battery. **Ans.**—The Eagles battery is virtually a Daniell cell of low resistance. It is not adapted to run a motor. The resistance of the motor thus wound would probably be about four ohms, and that of the battery at least as much more, making eight ohms, while the E. M. F. will be about one volt per cell, or four volts, giving a current of about 0.5 ampères, much too small to do any work with the motor. We should recommend using No. 16 B. & S. for the field and 18 B. & S. for the armature. A bichromate battery will give the best results. Several cells will be required. The question of batteries for this motor will be taken up in due course.

[61.] **Commutator** offers valuable suggestions which will receive proper consideration. Will he kindly send his address that we may communicate with him personally?

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Competing Quotation Companies.—The War of Rates Begun.—The Spring Campaign of the Underground Raiders.—A Legislative Commission to Enforce the Law.—Closing of the Electrical and Miscellaneous Stock Exchange.—The River and Rail Electric Light Co.—A Tournament of Morse Operators.—The Pneumatic Tubes.—The Mysterious Meter.

THE war of rates between the different quotation companies was precipitated by the decision of the New York Stock Exchange to organize a bureau of its own to furnish official quotations on equal terms to all companies which would bind themselves to supply only such subscribers as the exchange considers legitimate stock-brokers. This result has been reached after long continued discussion and deliberation by the Governing Committee. It is very doubtful whether the anticipated suppression of the bucket-shops will be accomplished. If the proposed plan is actually put in practice the company which accurately prints the quotations in advance of its competitors will be rewarded by the lion's share of subscribers. Success will depend upon the speed of the instru-

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ments, the perfection of the transmitter, and the skill of the transmitting operators. In this contest for the survival of the fittest there will probably be at least four entries: The Scott printer by the Gold and Stock Telegraph Co., the new Field printer by the Commercial Telegram Co., the Van Hoevenbergh printer by the Baltimore and Ohio Telegraph Co., and the Wirsching printer by the Stock Quotation Co. The two companies last named are not yet ready for business, while the two former are still using their old style of instruments. The Scott printers are finished and delivered, but it is now understood that they will not be introduced during the era of low prices.

Immediately upon learning the decision of the Stock Exchange the managers of the Gold and Stock company announced that on April 1st the rental of instruments below Chambers street would be reduced from $25 to $10 per month, which is the rate formerly established in order to crush out the Manhattan Quotation Co. 12 years ago. The stockholders of the Gold and Stock company are secured against any depreciation in the value of their holdings, as by the terms of its lease to the Western Union company a dividend of six per cent., payable quarterly, is guaranteed by the latter.

The underground wire workers have already opened the spring campaign. A special Albany despatch to the *Times* on March 10th contained the following:—

The Senate passed a humdrum day receiving bills and listening to the chunks of platitudes that dropped uninterruptedly from the lips of its members. Senator Daly introduced his bill relating to underground telegraph wires, mention of which was exclusively made in the *Times* editorial columns to-day. It provides for the appointment of a commission to carry out the Underground Telegraph Act of 1884. The commission shall devise a plan for underground wires within 60 days. The New York Commissioner of Public Works shall be *ex-officio* a member of the commission. The salary of the two commissioners shall be each $3,000 annually, and the expenses shall not exceed $10,000, the whole to be assessed on the companies.

The "exclusive" arrangement by which this underground raid is being manipulated through the columns of the *Times* is one of the peculiarities of metropolitan journalism. The Western Union Telegraph Co., and the Metropolitan Telephone and Telegraph Co., in this city, and the New York and New Jersey Telephone Co., in Brooklyn, are believed to be the only companies which are actually engaged in placing their wires underground. The Edison company, as is well known, has always used the subterranean system. It has, however, been extremely fortunate in having an apparently unlimited amount of money to invest in its plant.

On March 16th the Board of Aldermen sent to the Committee on Streets a resolution offered by Alderman Walsh revoking all permits granted to electric light companies to lay wires underground in this city except where the privileges so granted have been used. It is explained that a number of companies to which such permits have been given have never taken any steps to put their wires beneath the ground.

It is said that underground operations may be suspended during the coming summer through fear of facilitating the spread of cholera. Experts have already brought up similar objections to the proposed cable railway on account of the excavations which will necessarily be made to install it On all such questions the Board of Health in this city has arbitrary powers, and if the mortality arising from digging up the streets is likely to be any greater than that occasioned by overhead wires, which is practically *nil*, aerial lines may yet be allowed a renewed lease of life.

The Electrical, Manufacturing and Miscellaneous Stock Exchange has finally succumbed to the pressure of the times and will soon close. The enterprise was undertaken in the belief that there would be sufficient business arising from trade in electrical securities to support such an exchange and thus form a nucleus for a prosperous organization. Speculation, especially in new fields, was however paralyzed by the May panic last year, and it has been evident for some time that future success was extremely doubtful.

One of the novel projects of the day is the organization of the River and Rail Electric Light Co., of which Albon Man, of Brooklyn, is president, and whose invention evidently forms the basis of the corporation. This apparatus, which was patented March 10th, is intended to utilize the "current force of flowing waters in producing electric currents." It consists of an undershot water-wheel, mounted between two scows, arranged similarly to a catamaran. Upon one of the scows is mounted the dynamo machine, belted to the shaft of the water-wheel by the necessary number of multiplying pulleys to obtain the requisite speed. One of the objects of the invention is to provide temporary lights to place over bars and snags in western rivers. Such obstructions are liable either to appear or disappear without warning. The scows are to be anchored or secured wherever lights are required, provided, of course, that the current of the stream is sufficient to furnish the necessary power. One of the first public acts of this company was to introduce into Congress a year ago a bill "To authorize the lighting of the navigable waters of the United States with electricity." According to your Washington correspondent, writing under date of January 26, this measure has been practically killed.

Another local fast sending tournament is being organized under the management of Fred Catlin, and will take place in the lunch-room of the Western Union building on April 5. Three prizes are offered of $25, $15 and $10 each. After its termination it is believed that similar local contests will be held in different parts of the country, preliminary to a National Tournament of Morse telegraphing in this city next autumn.

The pneumatic tube system recently laid down by the Western Union Telegraph Co., between Dey and 23d street, is not proving an effectual substitute for the telegraph. The transmission through the tube, and the circumlocution at the terminals consume an average of over 20 minutes, about the time occupied by a messenger for the same distance if he travels by the elevated railway. This delay is not the worst feature however, for it is sometimes the case that a collection of messages disappears, although the carrier is not lost, as Jack Selden said when the mercury went down the sink spout, "because we know where it is." Out of 14 messages recently missing, one by one straggled along, until finally all but one was accounted for. If the paper used for message blanks was more highly finished they would not be so likely to lodge in the tube.

Electric light customers are not altogether happy under the reign of the electrical meter. The firm of Wilcox & Baird, brokers at 64 Broadway have been served by the Edison Illuminating Co. Mr. Wilcox says that the bills of the firm beginning in August were less than $5 a month, something less than gas, but that the cost increased about $1 a month. In January their bill was $8.21 and for February $8.67. A day after the last bill the moveable lamps were taken out by the firm and gas used instead of the electric light. Nevertheless, the electric light bill from Feb. 18 to March 19 was $9.29. At the office of the Edison company in Pearl street, it was stated that the bills of their customers naturally increased as the days grew shorter and vice versa. The bill of Wilcox & Baird this month was larger than last, however, although most of the other customers in the district had smaller bills. This could be accounted for on the theory only that more light than usual had been used by Wilcox & Baird. So long as the meter plates showed by decomposition that so much light had been used the company had no other alternative than to charge for it.

New York, March 29, 1885.

CHICAGO.

The Leakage Evil in Electric Lighting Circuits.—Various Interesting Electrical Experiments.—Increase in Incandescent Lighting.—The Perkins' System.—Arrival of the Lightning Arrester Vender.—A Miner's Safety Lamp.—The Latest Suggestion in Tower Lighting.

In the course of the electric light convention, recently held in this city, some of the delegates unintentionally let out the fact which has long been apparent to careful observers, that a very large proportion of all the electric light lines in the country have constantly, or nearly so, one or more ground leaks. This I hold is the great and nearly the only danger in using this wonderful force. The attempted remedy is of course a magneto call bell. These will usually, if good, ring through about 10,000 ohms resistance. Higher than that they seldom or never go, and a leak which such an instrument will not detect, may prove a very dangerous one, under peculiar circumstances which cannot be foreseen or known, until mischief has rendered it apparent. With a metallic circuit it is always the second ground which does the damage, and some method should be devised by which the first ground can be tested for daily, and that method, to be reliable, should be capable of manipulation by the party in charge of the dynamo or plant—the engineer, in a local plant, or the superintendent in a central plant. When this is done, and properly used, the hue and cry about "deadly electricity" will cease, and a huge club in the hands of the gas people and other enemies of electric lighting will have been disposed of. The newspaper reporter will have lost an item or two occasionally, but he can perhaps find some other sensation, which will not have for its butt a large and necessary industry, which despite its so-called terrors, is fast winning its way against all opposition.

Nearly every one has noticed the accumulation of minute particles of dust, lampblack, cotton shreds, etc., on the wires, particularly on arc light wires. Some experiments recently made by a French electrician clearly show this to be the result of electrical attraction. In the course of his investigations he obtained some quite interesting results in crystallizing vapors of salts, clearing a bell glass filled with smoke and the like, by a current of electricity.

A very pretty Leyden jar experiment may be made with an incandescent lamp and a rapidly moving leather belt. The capacity of the lamp for retaining the electricity is something wonderful, because of the very perfect insulation, and the rarified condition of the air within it. A Geissler tube is also a good condenser of the same sort. If into an incandescent lamp a considerable amount of current is stored, although the lamp is held in one hand, induction sparks will be given off the surface of the lamp to the fingers of the other hand, showing the high tension of the charge. I would suggest that caution be used in experimenting with these, as I know one party—no cards—who builded higher than he thought and surprised himself with his success.

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During the extreme cold weather of the past two months, the amount of atmospheric electricity developed everywhere has been a source of amusement and wonder to all but the initiated. Ears have been tingled, gas lighted, etc., in nearly every house in the city, and checker boards placed on tumblers used for insulated stools, while fur wraps of all descriptions have served for exciters. I learned a few days since the reason for all this, from an elderly party in a street car, who seemed quite learned on the subject. He said this sort of thing never was known till the streets were filled with electric light wires.

A curious little experiment with frictional electricity is that in which a long, light, fibre of silk is excited by drawing it through the fingers and holding it suspended in the air. Now if the fibre, while in this excited condition is touched quickly by the finger, the polarity at that point is changed, and if several points are thus touched, one after another, the fibre will show by attraction and repulsion a series of curves and nodes in its length. Of course this can only be shown in a dry, clear atmosphere.

Incandescent lighting is on the increase with the several companies just now. The Edison folks have several of the new buildings round the new board of trade, the United States people have a lot more, and the new comer, with the Perkins lamp and the Mather dynamo has just wired, and will shortly light the Grand Opera house. This company has already one plant which is making a very pretty show of light, and giving good results. One little novelty of Perkins's invention is a table light, in which four loops are placed in multiple arc. A key at the bottom of the lamp, permits the burning of one or more of these at the same time—thus giving eight, 16, 24 or 36 candle-power in the same lamp. The breaking of one filament does not interfere, of course, with the other three, and consequently one lamp can be made to last as long as four single ones, by using one carbon at a time.

The lightning arrester fellow has been around again with an electro-magnet, which charges with the current from a battery and closing, puts on a ground, don't you see? If that gentleman will close that magnet with the discharge from a Holtz machine, or a Leyden jar, I shall take pleasure in congratulating him; but until then I must hold to the old faith, unless he can arrange to slow up an atmospheric discharge by carrying it through a wet string or some similar resistance. As an old army operator once said, "You can always tell when a mule is going to kick, if you watch his ears; but lightning hain't got no ears, and is quicker'n a mule."

A new form of safety lamp for use in mines comes from across the water. This is the invention of Mr. Coad, whose object is to prevent the spark of a breaking circuit in a lamp from igniting the gases in mines. The arrangement consists in placing the ordinary incandescent globe within another, the space between the two being filled with water and carbonic acid gas under pressure. This pressure holds the circuit closed, through the medium of a flexible disc. Breaking the lamp relieves this pressure and breaks circuit at a point thoroughly protected from contact with the air of the mine.

A daring and eminent architect of Paris, Jules Bourdais, who planned the Trocadéro Palace, according to *La Lumière Electrique*, has proposed to construct an immense tower, 360 meters high, from the top of which electric lights will shed their rays over the gay and wicked capitol. Mr. Bourdais estimates the cost of a stone and also of an iron structure, either pseudo cylindrical or a truncated cone, with a heavy base. The first is comprised of a square ornamental base, with five circular stories, each with surrounding columns and an airy look-out surmounting this, above which is a crown-like ornament and a species of pinnacle, with a statue of the genius of science, capping the whole. The lamps are to be distributed on the edge of this crown, 100 in number, of 20,000 candle-power each, or a total of 2,000,000 candle-power. Huge reflectors are to aid in the dissemination of the light. The inner portion of the column will contain 16 chambers in each section, or 80 chambers in all, of 15 square meters each, and five meters high. The look-out will accommodate 1,000 sightseers and invalids seeking pure air, while a well, 8 meters in diameter from the deck to the ground, is suggested for experimental researches in philosophy—the descent of falling bodies, compression of gases, vapors, Foucaut's pendulum, etc. It is proposed to place this grand tower near Saint Germain l'Auxerrois, lighting up the old church whose bell in 1572 rang out the knell of the Huguenots, or at Pont-Neuf. The building which forms the base of the column 66 meters high is to be utilized for the necessary steam and dynamo power.

The phalanx which stood up so solidly for tower lighting at the late convention here, must look to its laurels.

CHICAGO, March 14, 1885.

PHILADELPHIA.

Experimental Test of the Bidwell Electric Railway.—An Injunction Against Removing a Telephone.—Decline of Brotherly Love in the Quaker City.—Councils Decide to Go Slow on Electrical Questions.—Narrow Escape of a Lineman.

THE officers and stockholders of the Bidwell Electric Railway Co. gave a very interesting exhibition of their new motor a few days ago. Among the guests invited were many well-known railway men and electricians. A track had been laid around the entire room 250 feet in length, and a car capable of holding 10 persons was placed upon it. The motive power was furnished by a five h. p. dynamo. In addition to propelling the car, electricity was furnished for several incandescent lamps in the car, and for large lights along the track. The same current also heats the car.

By a novel arrangement, which is attached to the car, salt or a chemical compound can be fed to the track in cold weather to keep it clear of ice or snow, and dirt is swept out by a brush which is also attached. The experiments were perfectly successful. I understand successful tests of the system have also been made in other cities.

Charles Gibbons, Jr., a lawyer, recently filed a bill in equity against the Bell Telephone Co. to prevent the removal of his telephone. Mr. Gibbons has had a telephone in his office for over three years, under the customary contract. He paid an annual rental of $100, and the company agreed to give him "efficient telephone service," that being defined as "the best service of which the instruments and wires are reasonably capable." In October last his service became defective and for five weeks preceding February 25th he had no use of the instrument at all. When he insisted upon making a proper deduction, the company refused to allow any rebate and threatened to remove the instrument. Judge Biddle granted a preliminary injunction restraining the company and its employés from removing the telephone or interfering with its use.

Although Philadelphia is known as the city of "Brotherly Love," I am inclined to think that that endearing term is a misnomer, inasmuch as we usually have a lawsuit or two on hand in reference to electrical matters.

At a recent meeting of select council the special order was the consideration of a resolution instructing the city solicitor to begin proceedings to recover the penalty of $50 under the act of June 13, 1882, in relation to the maintenance of poles and wires for telegraph, telephone and electric light purposes in the city of Philadelphia after January 1, 1885. In calling up the special order Colonel Banes said it would be well for councils to deliberate before acting rashly in so important a matter. He had recently visited Chicago and other cities with a special view to the study of the underground system and found that in none of them had any universal system been adopted. New York had 27 miles of underground wire in successful operation, while Boston had 15,-000 feet (in sections of 3,000 feet) and Chicago 800 miles, the latter being telephone wire. There was no means of telling what would be the improvements in electricity, they were so many and so frequent. He thought it behooved councils to deliberate carefully before acting upon this resolution. They must take into consideration the rapid marches of science What seemed impossible yesterday might be easily accomplished to-morrow. He held that some portions of the main lines of telegraph might be put underground, but showed that there were certain parts of the city where poles or house wires would be absolutely essential to make connection. In conclusion he referred to the fact that the question of councils' power to tax telegraph wires was now under consideration by the Supreme Court. His motion to indefinitely postpone the consideration of the resolution prevailed.

There seems to be quite a lull in electrical matters hereabouts just at present, but as soon as the weather shows an inclination to get settled there will no doubt be a change.

Reuben A. Weeks, a lineman of the Bell Telephone Co., had two fingers of his right hand and the thumb of his left hand burned by electric wires on the 17th. He was on a pole tightening wires, and thinking it perfectly safe in daylight he caught hold of an electric light wire. The shock rendered him unconscious. He hung on until his fingers were badly burned, when he fell and was caught on a wire by the strap of his climbers. He remained suspended in the air, head down, for several minutes, until a ladder was procured and he was rescued. When brought down he was still insensible, and was taken to the hospital, where he was soon restored to consciousness. One finger was burned entirely off, and the other and the thumb were amputated.

PHILADELPHIA, March 19, 1885.

BOSTON.

Electric Street Lighting Compared with Gas and Oil.—The New Telephone Exchange.—Attempted Legislative Restriction on Telephone Rates.—Discrimination against the Baltimore & Ohio Telegraph Co.—Opposition to the Proposed Increase of the Bell Company's Capital.—Newport, R. I. Authorizes Electric Lighting.—The American Rapid Bondholders to Bring Suit for Interest.

THE annual report of the superintendent of lamps for the year 1884 has been submitted, and from it I glean the following statistics showing the comparative extent of electric lighting. The number of public lamps of all kinds in the city of Boston, Jan. 1, 1885, was as follows:

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Gas Lamps	9,781
Large gas lamps	36
Oil lamps	2,591
Electric lamps	401
Total	12,809

The total cost of gas lighting	$255,463.30
" " oil lighting	5,565.93
" " electric lighting	90,785.80
Total	$351,815.03

The relative total cost of the different systems per lamp was—

Small gas lamps 4 feet each per year	$ 31.85
Large " 30 " "	$121.22 to 180.31
Oil lamps, each per year	13.78
Electric lamps, each per year	226.40

The large gas lamps are in use in public places, but some of them do not burn all night.

The introduction of electric lights in this city for street lighting dates from February 15, 1882, beginning with five lights in Scollay square, which had been previously lighted by the Brush Electric Light Co. as an experiment. According to the report of the department there were in use

January 1, 1883	114 lights
" 1, 1884	381 "
" 1, 1885	401 "

These lights are distributed as follows :—

Brush—	City proper	178	
	Roxbury	40	
			218
New England Weston—	City	54	
	South Boston	63	
	Charlestown	24	
			141
Merchants—	Boston Common	3	
	Public Garden	18	
	Back Bay	5	
			26
Union			16
			401

The electric light competition has forced the price of gas down during the year. New contracts were made with seven of the gas companies furnishing gas to the city and annexed suburbs last May, the prices ranging from $1.75 to $2.00 per 1,000 ft. The public lamps are burned every night throughout the year, a total of 3,828 hours each. In 1879 the automatic glycerine burner was adopted, and has continued to give good satisfaction, and to accomplish all that is claimed for it. The lanterns are of tinned copper, and are so constructed that the names and numbers of streets may be placed in them.

Colored glass is used for name and number signs—the letters and figures being made by the sand blast process. Nearly one-half of the gas lamps stand on the corners of streets ; and where they have been displaced by electric lights, the removal of the street names and numbers has caused great inconvenience and complaint.

The large three-cluster burner "Bray" lanterns in use give good satisfaction ; they cost $40 complete. In addition to these 30 feet burners, the demand for more light has caused the introduction of many five and nine feet burners. The entire cost of the lamp department for the municipal year was $491,654.31.

The multiple system as manufactured by the Western Electric Co., largely under Scribner's patents, was inaugurated at the new Boston telephone exchange, 50 Pearl street, on the 22d of February—supplanting the Gilliland switch-boards. To introduce this and to change systems and offices without interfering with business has required a vast amount of work, thought and time. As extra attention is to be given to out-of-town talking all of those lines are separate from the exchange room. The change necessitated different numbers, and new lists of subscribers. At one o'clock on the 22d the wires were removed from the old building to the new. It has been a trying and perplexing thing to arrange all of the details and it is to be hoped that it will work enough better to pay for the trouble and expense. Great credit is due to Mr. John J. Carty for the success that has attended the improvement. The calls were somewhat irregular for a few days, the school house being new the girls did not get the hang of it at first, but its all right now. The operating room is first-class in every respect, one important advantage being the clear strong north light which they enjoy.

At the State house, on Feb. 18, the committee on mercantile affairs gave a hearing upon the petition of Lowell parties for a restriction on the rates charged by the American Bell Telephone Co. The case was opened by Parker C. Chandler, who argued that telephone companies should be obliged to make connections with all telegraph companies. He complained that the Baltimore & Ohio Telegraph Co. was not permitted to have telephone connection with the Bell company's system, and read numerous legal decisions to support the point that in the Western States the leaning of the courts has been in the direction of greater freedom, and of the doctrine that a telephone company is a common carrier. H. C. Bolles, agent of the B. & O. at New Bedford, testified of the refusal of the Bell company to permit his company to have a telephone connection. H. W. Kilbourne, superintendent of the Boston District Telegraph Co., stated that the Bell company had refused his request for a telephone, though it would be willing to provide such connection if its contract with the Western Union permitted. The District company is in the service of the B. & O. and the Commercial Cable Co. A. G. Ryder, agent of the B. & O. at Taunton, testified to the same effect as Mr. Bolles. O. L. Barron, the B. & O. agent at Gloucester, said he had a telephone in his office, and used it, but was not supposed to. Mayor Donovan, of Lowell, stated that the B. & O. in Lowell, had been refused telephone connection.

On the 26th, the Western Union side was presented by Geo. S. Hale. He seemed to think his case was prejudiced, as he had been informed the W. U. T. Co. was regarded as a monopoly, the property of Jay Gould, etc. To combat such groundless ideas he showed that 33,428 shares of W. U. are held by 410 residents of Massachusetts, and that in 10 years the company has paid above $100,000 in taxes, while the B. & O., which is at the bottom of the present attack, has but $10,000 capital in the state, held in 100 shares, while but 40 places in New England are reached by its lines. He claimed that the W. U. had a right to make any contract it pleased with the American Bell company. He proposed an amendment to the bill under consideration, which was a proviso that no existing contracts should be abrogated. P. C. Chandler submitted a shorter draft of his bill requiring the Bell company to admit all telegraph companies to its facilities on equal terms. He claimed that patents are subject to police regulation in the several states, and convey exclusive rights to individuals only to the extent that any rights at all are permitted.

On March 4th, the committee on mercantile affairs began to hear the petition of the Bell Telephone Co. for an alteration of its charter so as to allow an increase of its capital stock, also to hear parties relative to placing telephone companies under state supervision. Hon. Geo. A. Bruce opened for the Bell company with a general history of the telephone, and stated what the company desired to do with the increased capital, it being principally their desire to enter into the long distance telephone business. Wm. H. Forbes, president of the Bell company, dilated upon the desirability of long distance telephone lines, and purchase of patents for such business, and corroborated Mr. Bruce's statements. Mr. Edward Atkinson stated that long distance telephony would be of great benefit to manufacturers, and recommended the increase of capital stock asked for. Col. Jonas H. French stated he was in the Senate when the present capital was asked for and thought $15,000,000 too much, but now thinks that $30,000,000 will prove too little rather than too much ; and urged the desirability of keeping the corporation in Massachusetts. He did not think there was any justice in regulating telephone charges by legislation. The matter should be left to supply and demand, the present rates not being extravagant for the service rendered.

A petition, stated to have been signed by 4,500 business men and others, to be presented to the legislature, "that charges for telephone service may be reduced and limited by law in this state" —has been one of the features of the month of February. All persons in sympathy are requested to send their names to the "Telephone Subscribers' Union," P. O. box 2,734, Boston. It is very desirable to have telephones cheap, but I wonder if these parties would approve of petitions being presented to the legislature to have prices fixed for groceries, hides, leather, etc.? Perhaps the whole affair is to offset the anticipated advance in telephone rates.

On the 10th, the committee listened to further testimony relating to the reduction of charges. The opposition to the Bell company comes largely from Lowell, where a great proportion of the stock of the New England Telephone Co. is held. These parties paid good prices for their stock originally and when the consolidation of the several New England companies was effected and the American Bell company obtained 50 per cent. of the consolidated stock, the original stockholders found themselves divided by two. The legislature will probably not interfere in the matter.

Newport, R. I., is still without a contract for the lighting of its streets. After the practical abandonment of the electric light the force of public opinion led to a consideration of its merits. Detailed proposals have been made by several electric light companies for the street service, and the gas and lamp committee sent over two hundred letters of inquiry to as many cities and towns using the electric light. A resolve to use the Thomson-Houston system has been defeated, but the general cause of electric lighting has triumphed, and the citizens and summer visitors will have something more than the light of the moon to see their way home by—though the moon may wane, the electric light will shine.

A complaint has been filed by Arthur D. Payne, of Providence,

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R. I., in the clerk's office of the United States circuit court against the American Rapid Telegraph Co. of Connecticut, *et al.* This bill is in the interest of holders of interest coupons of the first mortgage bonds of the company in Connecticut and in other states for failure to pay the interest on the coupons. A receiver is asked for, pending the suit. The bill is returnable April 6.

BOSTON, March 17, 1885.

NEW ORLEANS.

An Improvement in the Financial Outlook.—Exhibits of Maryland, Pennsylvania and New Jersey.—The Crescent City Dependent upon Electricity pending the Gas War.—Flourishing Condition of the Local Brush Company.—Street Lamps Borrowed for Household Use.—Successful Bidders for City Lighting.—Telephone and Time Telegraph Affairs.

SINCE the dawn of clearer skies on the passage of the loan bill by Congress, the electric light people of the exposition wear more cheerful faces. The prospects are that they will certainly get paid for all work done during the past three months, but whether or no they will be as successful for the balance of the term remains to be seen. Owing to the fact that all bills due to parties outside of Louisiana taking precedence, the Edison, Jenney and Thomson-Houston companies may fare better in the distribution of the $350,000, than the Louisiana and Brush, both of which are home institutions. In the financial statement rendered to Congress by director-general Burke, over $30,000 were entered as due the lighting companies. The Edison lamps in the government building have not yet been lighted, and now it begins to look as though they never would be. The dynamos are ready, and the offices wired, but the motive power is lacking, therefore it would seem that the company is not to blame. The Art gallery was lighted on the 14th for the first time.

The Baltimore and Ohio R. R. Co. makes quite an electric display among the Maryland state exhibits. A model of the original patented Morse telegraph instrument has by its side one of the Selden sextuplex system, the company owning the patents covering the latter. A Page motor is shown, represented to be a model of the first electrical invention ever used to propel a railroad car, making its trial trip over this road in 1851. Here is also the original first telegram ever transmitted, as mentioned in a previous letter.

In the Pennsylvania department, and displayed by Partrick and Carter of Philadelphia, is a case of telegraph instruments, switches, etc., with vulcanized-fibre bases and trimmings; also samples of the fibre itself. Many passers-by are startled in the New Jersey aisle, by the sudden ringing of an electric bell; inquiry developing the fact of its being caused by their own footsteps on an Applegate electric mat, not observed, as it is covered by an ordinary rug. This must prove a desirable burglar alarm in warm climates, where for a greater portion of the year doors and windows must be left open all night.

Our many visitors have lately had an opportunity to see how our city fathers run things in this town—and no tax is levied upon them for taking items to be used in improving their own governments when they reach home. Nearly every year the gas company has a falling out with the council and shuts the gas off from all street lamps, until they come to terms. This is now the "accepted time" and for ten nights the streets—save the few which enjoy the electric lights—have been as dark as Erebus. It seems that the great number of electric lamps put up within the past year have displaced very many gaslights, and still the gas company insisted upon burning them and charging therefor. Recently, however, the contract expired, and it is now the number of lamps to be contracted for upon which the trouble hinges.

Heretofore the local Brush company has had a clear field and it has improved its opportunities. It was organized in 1881 and on February 1st, 1882, steam was turned on for the first time. Eighty lights was then the capacity of the plant, 40 of which were lighted that evening. Success characterized every effort and business increased steadily until to-day when there are over 700 lamps in use. Five miles of the city front on the river are furnished with 100 lamps. An iron tower 175 feet in height and carrying six lamps was erected by the company, to show what it could do in that line. This it was hoped would lead to adoption of that system for the rear of the city, a section some eight miles long by over a half mile wide, and perhaps it will, but by another company. Among the exposition light people, I have heard it said upon all sides that the New Orleans company or rather the South-western Brush Co., has the finest Brush plant and lamps to be found anywhere. By a recent change of the armatures, old 40-light machines have been increased in capacity to 65 lamps: 15 of these dynamos are now running, being driven by three Atlas-Corliss engines. A portion of this city is not blessed with gas mains, the streets as well as buildings being lighted by oil. Some time since, several of the residents of this suburban or "oil district" as it is called, appealed to the council for electric lights, saying that some of the more enterprising citizens were in the habit of borrowing the street lamps at night, returning them empty in the morning! In the meantime the streets were in darkness. Perhaps the trouble was caused by there not being enough lamps to go round, who knows? This state of affairs struck the council as not being just the thing, so they advertised for bids, and after some delay, accepted by a large majority that of the Louisiana Electric Light and Power Co. This called for about 300 lamps—20 towers carrying six each at $1,200 per year, and the balance on poles at $146, per year. This contract now awaits the Mayor's signature, but in the meantime the Brush company have offered lower figures, so it remains to be seen what will be the result. The Louisiana company proposes to use the star tower and Jenney system upon all city contracts it may make, but for other purposes the Excelsior machines and Muller lamps will be adhered to. When the exposition is over, they will bring down their large plant and compete for a share of the private lighting of the city.

Telephones seem to be still in demand. The great Southern company has finished the copper wire line to Baton Rouge, and it is working splendidly. A steel wire of same size, No, 14 has been put up to Terre Haute, a distance of 28 miles. These two lines must prove a boon to the people along the routes, as heretofore they have had no direct communication with the outside world. The branch exchange at the exposition has proved a successful venture and will net a handsome profit. The time service is meeting with favor, 248 clocks are out, and the prospects good for the number soon to be increased to 300. Sixty have been placed in the government building as an exhibit. One in the office of the writer keeps accurate time, and has become an "institution."

The Crescent City Telephone Co's poles are going up on our principal streets, and the stringing of wires commenced. The advantage of having two companies will soon be discovered, that is if any exists.

NEW ORLEANS, March, 15, 1885.

SAN FRANCISCO.

The Coming Opposition Telegraph System.—Telephones and Electric Lights in the Extreme North-west Where Some of the Old-Timers are Located.—The Rival District Companies.

I CAN now state on reliable authority that operations will begin on the construction of a new opposition telegraph on this coast almost immediately. The recent railroad developments, and the peculiar manipulations of Senator Stanford would lead an ordinary thinker to believe that it looked as if he meant "to go the whole hand alone," and it would not be surprising if the Western Union at an early date received the stipulated "six months notice" of a desire to break the contract now existing between them. If this will culminate, as events forebode it will, then with Mr. Crocker's friendship and implicit reliance on James Gamble, do not be surprised to see Mackay, Bennett, Bates, Stanford & Co., a powerful rival to Jay Gould and his connections.

A system of interlocking railroad switches controlled by electricity is being introduced at Oakland. Will Slater is to have charge of the system.

The telephones on the Columbia River and Puget Sound are as successfully operated as in California. In Portland and East Portland there are 400 telephones in connection with the main exchange, and about 90 Brush lamps are lighted. These are under the management of J. H. Thatcher, who in the palmy days of the Comstock used to send cipher messages at the rate of 80 an hour to William Foley. In Seattle there are about 170 telephones and all the saw-mills on the Sound are lighted by electricity. Geo. D. Snow is general overseer. Tacoma too, has a thriving exchange, and our staid neighbors in British Columbia are not behind-hand. F. H. Lamb who with Frank Drummond and Charlie Moore, learned self-denial in Libby prison in '62, is superintendent of telegraph, with headquarters at Portland. John Henderson, ex-manager of Salt Lake, is also in Portland. J. W. Hayes is manager of the Portland office and assists Mr. Lamb in some of his outside duties.

The rivalry that exists between the San Francisco District and the American District companies is very peculiar. Every week one company makes the other a present of a large number of its own boxes. A few days ago, 160 boxes taken out by order of various subscribers and supplanted by San Francisco District boxes, were sent to the American District, the compliment was returned with interest later, and still the war goes on. It is said Mr. Gill of the San Francisco company is in negotiation with Mr. Gamble to do the city delivery for his company when it reaches here, in the same manner as the American District do it for the Western Union.

SAN FRANCISCO, March 7, 1885.

WASHINGTON.

Arc Lamps at the White House Entrance.—Establishment of Police Patrol Stations.—The Telephone Wires Going Underground Rapidly.—Telegraph Instruments Removed Without Authority.—Telegraphers' Mutual Relief Association.—Important Decision in Incandescent Lamp Patents.

To assist in giving *eclat* to the occasion of the inauguration of President Cleveland, the United States Electric Light Co., at con-

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siderable expense, put up eight of their arc lights in front of the executive mansion, four directly in front of the main entrance, one at each gateway, and one midway on each of the circular roadways leading from the gates to the mansion. In order that the work might be first-class, the wires were laid in underground cables and led up through the posts so as to be entirely invisible. The effect was excellent, and gave so good satisfaction that an order has been given for a continuance of the lighting, in place of the gas lamps by which the approaches to the mansion have heretofore been lighted. The incandescent lights for the Interior department, mentioned in a former letter, have been put in by this company, and give much satisfaction; they are used in the sub-basement—which is never penetrated by day-light—amongst a mass of papers piled up as closely as is possible, and at the same time reserve access to them. The danger of fire, by the flame from the gas burners blowing against the inflammable files is by the substitution of the electric light avoided, a precaution not to be lightly estimated in a building of this character, especially after the experience of a few years ago.

Owing to the unusually crowded condition of the streets, at this time, and the severe weather, the United States company has not yet laid the underground wires for lighting Ninth street but expects to now put in the wires and light the street at once. The company seems to be well established, and doing a good business, at reasonably remunerative rates. A day circuit has recently been started for the convenience of business houses, in lighting basements, dark passages, etc. Sufficient patronage has been secured to warrant its continuance.

The district authorities have taken another forward step, and had the Gamewell system of patrol stations put in the fifth precinct, making two of the eight police precincts that are now supplied with these stations. Their use in the seventh precinct where they have been on trial for a year or more, has been very satisfactory, and the commissioners would have them put up in all parts of the district, but for want of funds that can be applied to that purpose. Unless sanctioned otherwise by Congress the work will have to be done precinct by precinct each year until the whole is done. The cost of the 30 stations already put in is about $7,600. Some of the larger and less densely populated precincts may cost a trifle above the average.

For the past 12 months the Chesapeake and Potomac Telephone Co. has been engaged in making a permanent plant of what was the merest temporary structure. To a great extent the badly insulated, and illy secured air lines have been replaced with underground cables until there are now over 10,000 miles of conducting wires underground. Most of this work has been done in Washington, and it is proposed to follow it up with a further outlay of $30,000 during the coming summer. To accomplish this it has been necessary to pass dividends for some time past, but those interested seem perfectly satisfied with this disposition of the earnings. The earnings of the company in 1884 were 33 per cent. more than those of the preceding year.

One day last week some scoundrel, on mischief bent, entered the lobby in the rear of the reporter's gallery in the Senate, and amused himself by tearing out the telegraph instruments of the Baltimore & Ohio company and the instruments of the United Press on the opposite side of the lobby. Who the miscreant was, or what was his motive is a mystery. The suggestion that it might have been some dissatisfied operator is discarded because of the wires of the United Press having suffered, as that organization stands high universally with the craft. It was probably the freak of a drunken outsider, for the manner in which the work was done shows a want of knowledge of telegraph matters. It was fortunate for the Pennsylvania troops that they had gone home or it would certainly have been charged to them.

Owing to the hurry and bustle incident to the last days of Congress the necessary order was not given for lighting the Senate chamber, corridors and committee rooms, much to the regret of many senators and employés, to say nothing of the parties interested in the introduction of the light. As the extra session is only for the transaction of executive business the order cannot be given until Congress re-assembles in December. It will doubtless then be given for the cloak-rooms, corridors, committee-rooms, etc., omitting perhaps the lighting of the ceiling over the chamber, from whence the impure air is carried by fans out through the roof and does not reach the chamber or any part of the building.

The Telegraphers' Mutual Relief Association of this city, recently held its third annual meeting. The old officers, D. Marean, president, James B. Austin, secretary, and J. H. King, treasurer, with the old executive committee, were re-elected. The treasurer reported $385 on hand and $145 paid out in sick benefits during the year, making a total of $458 benefits in three years. The dues in this association are but 50 cents per month and seven dollars a week are paid whenever a member is prevented by sickness from attending to his ordinary business.

All the telegraph offices in the city were over-crowded with matter during Inauguration week, but they generally managed to get off their business. It was too much to expect of the average messenger boy that he would hurry out with his messages and return promptly with the troops parading the streets in all directions, presenting to his boyish vision probably the greatest military spectacle of his life. The offices put out placards "Boys Wanted" but the American urchin was not disposed to lose the show for a day or two of employment, and the messages had to wait till "Young America" was ready to deliver them.

It is rumored that the interference in the patent office, which has been in progress for several years, between Sawyer & Man and Edison, involving the question of priority of invention of an incandescent lamp filament made of carbonized fibre, has been finally decided in favor of Sawyer and Man. This is likely to have an important bearing on the future control of the incandescent lighting business in this country.

WASHINGTON, March 23, 1885.

ELECTRICAL NEWS AND NOTES.

THE TELEPHONE INTERFERENCE.—DECISION OF THE COMMISSIONER OF PATENTS.

CASES A AND B. VOELKER *v.* GRAY *v.* EDISON *v.* BELL. CASE G. EDISON *v.* GRAY *v.* MCDONOUGH *v.* BELL. CASE NO. 1. VOELKER *v.* EDISON *v.* IRWIN.

Decided March 3, 1885.

1. When an applicant seeks to overthrow a patent granted to one who, though junior in date of conception, has yet shown diligence in filing his application and reducing his invention to practice, the former must show entire freedom from laches; and doubts should be resolved in favor of the patentee.
2. It is not enough for a party to show that he was experimenting in the direction of the invention, but he must have matured his conception so that it can be materialized into an operative device. The conception which the law recognizes is not that of the result to be attained, but that of the means to produce such result.
3. The specification of an application for an alleged pioneer invention is addressed to those skilled in the art as it existed before the making of the particular invention therein referred to, and is not to be supplemented and aided by knowledge of events transpiring at a subsequent period, or derived from another's invention of the same thing.
4. An occasional accidental operation of a device, varying from its usual operation, and which is at war with the principle upon which it was designed to act, is not a sound basis for a claim as an inventor to a device capable of uniformly producing similar effects.
5. The declaration of an interference is made on the assumption that the application or patent put in interference covers an operative device, but it by no means follows that such presumption is conclusive; the question of operativeness may be raised and considered in determining the question of priority.
6. The controlling issue in this contest is, in howsoever many claims or subordinate issues it may find expression, a speaking telephone. The inventor of an art and apparatus for transmitting articulate speech cannot be defeated or put under tribute by those who claim to have invented certain constituent elements, but who certainly never produced the completed invention—a speaking telephone.
7. Bell is adjudged the prior inventor of all the issues save D and No. 1, and upon these latter two, priority is awarded to Edison.

THE SPEAKING TELEPHONE.

APPEAL from the Examiners-in-Chief.

Cases A and B.—Application of W. L. Voelker, filed May 19, 1879. Application No. 1, of Elisha Gray, filed October 29, 1877. Application No. 130, of T. A. Edison, filed April 27, 1877. Patent No. 174,465, dated March 7, 1876, of A. G. Bell.

Case G.—Application No. 48, of T. A. Edison, filed December 24, 1877. Application No. 3, of Elisha Gray, filed October 29, 1877. Application of J. W. McDonough, filed April 10, 1876. Patent No. 174,465, dated March 7, 1876, of A. G. Bell.

Case No. 1.—Application of W. L. Voelker, filed September 26, 1879. Application No. 141, of T. A. Edison, filed July 20, 1877. Application of J. H. Irwin, filed May 24, 1879.

Mr. G. W. Dyer, for Voelker.
Messrs. Baldwin, Hopkins & Peyton, for Gray.
Mr. L. W. Serrell and *Hon. Roscoe Conkling*, for Edison.
Mr. J. J. Storrow and *Mr. Chauncey Smith*, for Bell.
Mr. W. W. Hicks and *Mr. S. A. Duncan*, for McDonough.
Mr. G. W. Dyer, for Irwin.

BUTTERWORTH, *Commissioner:*

The hearing of this case before the Examiner of Interferences was in the latter part of 1882. He held the case under advisement about eighteen months. His decision is very full and reviews the law and evidence with great elaboration and care. The printed decision makes a volume of over three hundred pages. Every fact and phase of the case were carefully and critically considered, and every conclusion written out. The decision was in favor of Bell on all the issues except D, No. 1, and G. In issue G, priority was awarded to McDonough. In issues D and No. 1, Edison was adjudged to be the prior inventor. From the decision of the Examiner of Interferences an appeal was prosecuted to the Examiners-in-Chief in cases A, B, C, E, G, J, L, and No. 1. No appeal was taken in cases D, F, and I. The case was again fully argued, held under advisement several months, and a very full opinion rendered by the Examiners-in-Chief in October last. The action of the Examiner of Interferences was affirmed, except as to issue G, in which priority was awarded to Bell. From this decision the case was appealed to the Commissioner, and seven

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days devoted to the hearing. Some additional testimony given by Professors Young and Brackett, and considered in the argument, is before me.

Counsel are thoroughly familiar with every fact disclosed by the record which is important to any one of the issues; nothing which has any important bearing on the case has escaped consideration in the argument. In the course of the several hearings all that savors of husk and chaff has been cleared away, and the important controlling evidence, with the exhibits, drawings, and models, presented.

The time I have at my disposal to devote to the preparation of a decision precludes me from reviewing in an elaborate opinion the several points considered. I had proposed to do this, and had arranged notes of evidence and decisions accordingly; but I find that the time within which the decision must be signed is too brief to enable me to properly perform that work. If on examination of the evidence and consideration of the arguments I had become convinced that the findings and decision of the Examiners-in-Chief were erroneous, or if a serious doubt in that behalf had been raised in my mind, I would have felt constrained to leave the case undecided to be reheard by my successor. Had I reached a different conclusion, it would have been desirable that the reasons for overruling the decision of the board should be stated at length.

In reaching a right decision in a case like this, where the interests involved are great, as well as the honor of inventing an instrument so wonderful in its character and uses as the telephone, certain probabilities which always inhere in ascertained facts and conditions must inevitably have great influence. As a guide to truth it is safer to rely upon the actions of men than upon their expressed declarations, where the actions and declarations are inconsistent. Individuals, as a rule, act and speak in harmony with their own interests, certainly if consistent with truth. All persons reason in the direction of their desires, and resolve doubts in their own favor. When the dim and distant recollection of a party concerning his own or the conduct of another, in a matter of great interest to him who speaks, is found to be wholly at variance with what the known facts in that connection would naturally suggest and prompt, the fair inference is that the recollection of the witness is at fault, and that the logic of the known facts points nearer to the truth. It is natural for persons to hunt hastily through the pigeon-holes of memory, where unpleasant or damaging truths are supposed to be stored away; and, on the other hand, it is just as natural to encourage and quicken the pace of a lagging and uncertain recollection which is believed to contain even a fragmentary fact which will tend to mend a flaw in a title through which valuable interests may escape.

When an applicant seeks to overthrow a patent granted to one who, though junior in date of conception, has yet shown diligence in filing his application and reducing his invention to practice, the former must, in view of the importance, not merely to the patentee but to the general public, show entire freedom from laches. Nothing could sooner bring the patent system into disfavor than to permit a patent granted for a valuable invention in which thousands have become interested to be overthrown by a competitor in the same field of invention on evidence which fails fully to establish the superior claims of the junior applicant to be adjudged the prior inventor. And it is in view of this fact that doubts are resolved in favor of the patentee. See *Cushman* v. *Parham*, C. D., 1876, 130; *Wheeler* v. *Chenoweth*, C. D., 1869, 43; *McKnight* v. *Van Wagenen*, C. D., 1876, 127; *Richardson* v. *Denza*, C. D., 1870, 156; *Morse* v. *Clark*, C. D., 1872, 58; *Gray* v. *Hall*, C. D., 1871. 129; *Busha* v. *Phelps*, C. D., 1876, 119; *Wheeler* v. *Clipper Mower and Reaper Co.*, 6 Fisher, 1: *Stoner* v. *Clark*, C. D., 1877, 92; *Towers* v. *Pease*, C. D., 1878, 6; *Sargent* v. *Burge*, C. D., 1877, 62. And also the following court decisions: *Ellithorpe* v. *Robertson* (2 Fisher, 83;) *Union Sugar Refinery* v. *Matthessen* (2 Fisher, 62).

To defeat a patent it is not enough for an applicant to show that he was experimenting in the same field of investigation, and that his experiments finally led up to the invention in controversy. He must have been first to conceive *the thing* in controversy; not merely to have *conceived it possible to construct a device* which would produce the result sought. In the case under consideration it was not enough for any one of the parties engaged in the interference with Bell's patent to show that he conceived that an apparatus could be so constructed as to transmit articulate speech by the utilization of an electric current. Such an idea was not new, nor does it occur that apparatuses were wanting which were constructed for that purpose and which would transmit or reproduce sounds. The thing for which the commercial and scientific world was waiting was a method and apparatus for transmitting articulate speech in such manner as to preserve what the scientists and counsel term "*quality*," by which is meant that characteristic of sound which enables us to distinguish two sounds which have the same pitch and the same intensity from each other. It is the quality of sound which enables us to distinguish the voice of one individual from that of another. It is not enough that an applicant ranging through the field of experiment unconsciously stumbles upon that which is nearly related and very similar to the device in controversy. The conception must not be of the result to be attained, but the means (which is the patentable thing) to produce that result. As long as there was a missing ingredient, in the absence of which the means utilized was a failure and the desired result unattainable, the invention was incomplete. The question is, what was in fact accomplished, *not what could have been* had the inventor possessed the light which he subsequently obtained, either by research or from a more successful competitor. There is not unfrequently a disposition on the part of an applicant to confound a strong desire in the mind to produce certain results by some means of which he has but a vague and indefinite conception with an intelligent conception of a machine adapted to accomplish those results. It is in such cases that the desire, coupled with the imperfect conception of a device, ripens and matures in the light of subsequent knowledge. That of which the law takes notice is not the maturing, but the matured conception, which can materialize in an operative device; but it very frequently occurs that the inventor confounds his original desire and later conception and gives the latter the date of the former, and does it innocently. In such cases we appeal to the inherent probabilities, which are always the ear-marks of truth. One is found in the conduct of men - for instance, where a person has been searching long and earnestly for a valuable thing which he is anxious to utilize, and can only utilize when found by introducing it to the public. If the searcher is successful and develops the valuable thing sought, he is not likely to conceal it. He does not put it aside and out of sight for years, but he at once takes it to the waiting public. In other words, he acts reasonably and in accordance with what the experience and observation of men teach us is natural and logical under the circumstances.

It occurs in this case that Voelker in his search discovered what had been known to the scientific world for fifteen or twenty years. It was not what the public demanded and was waiting for. It has no value, even as a scientific toy. After Bell had invented and successfully introduced his speaking telephone Voelker unpacked his trunk and brought out the device mentioned, and in the light of what Bell had taught the world concluded that he (Voelker) had been ahead of Bell in producing a speaking-telephone, though unaware of the fact. True, his models did not and could not talk when he wanted them to talk, and when for the purposes of the public and of this case they should have talked; but, as stated, since the advent of Bell's telephone it is urged that the Voelker device, as he constructed it in 1877, and stored it away, has during its retirement become loquacious. The same may be said of McDonough's invention. It was no substantial improvement on Reis's. Whatever defects McDonough considered to exist in the Reis instrument, he did not regard the palpable make-and-break element to be one, since he provides in his best model, not for the imperceptible make-and-break of which Professors Young and Brackett speak in their evidence taken in the case of the *American Bell Telephone Company* v. *The Overland Telephone Company of New Jersey*, and which can hardly be regarded as coming within the definition of what McDonough requires and provides for in his telephone, but a palpable make-and-break of the current.

The circuit-breaker mentioned and described in the specification of McDonough and shown in his drawings is treated by his able counsel as a mere adjuster, peculiarly adapted to the purpose of so regulating the current as to attain the best results—whether that was to keep the circuit closed, to make the theoretical make-and-break of Professors Young and Brackett, or the palpable, perceptible make-and-break of McDonough. In this model of McDonough the learned counsel finds all the elements required, and in proper combination and perfect adaptation to the use called for in issue G; for, says counsel, if it be true, as claimed, that McDonough's *theory* required a make-and-break system in which the makes and breaks should be palpable, yet if he did, nevertheless, in fact produce a device that supplied not only the conditions of a make-and-break system, but also of the closed-circuit system of Bell, having produced the *thing* sought, it is not important that his theory was unsound, since he was not required to have any theory about it. What the public wanted, what the commercial world would buy and pay for, was an instrument that would produce the results sought without reference to or concern about the theory or reasoning of the inventor, since he may have given the world a useful invention, and yet have held a very erroneous theory in regard to its scientific operation.

General Duncan says the true and only lawful test to apply to the McDonough specification is to determine whether the description is such as to enable a person skilled in the art to make a speaking-telephone. In this connection it must be supposed that the McDonough specifications were addressed to those skilled in the art as it existed before the invention of the speaking-telephone. The speaking-telephone was what McDonough was trying to invent, and his apparatus reflected his best conception of that art and the means to practice it; and Bell's specification indicated his conception of the art and the means adopted to practice. There were at that date none skilled in the art as it is now understood, and the most and best an electrician at that time

could do would be to intelligently follow the specification contained in the application. In following the McDonough specification the Reis instrument would be produced, while an intelligent construction in accordance with the Bell specification would, as it did, produce a speaking-telephone. As an abstract proposition, I agree that General Duncan is correct; but his reasoning, when applied to the facts in this case, is more ingenious than sound. That the circuit-breaker used by McDonough was intended to perform just the office its name implies cannot be seriously questioned. That it was not a mere adjuster to regulate the flow of the current so as to vary it between full force and zero, with an occasional range to the latter, which I understand to be the make-and-break contemplated by Professors Young and Brackett, is utterly improbable. That it was intended to preserve contact, and so maintain a closed circuit, is unreasonable. Nothing in the name of the device (and the name clearly points out its function) suggests such a thing. Nothing said in the specification in regard to it is at war with the function ascribed to it by the name by which it is designated. It occurs in this case that that which counsel referred to as a mere theory or philosophical disquisition of McDonough is of controlling importance, because he either conceived a speaking-telephone within the terms of the issue or he did not. There is no pretense that he did not make his model in accordance with his conception (else his model would not illustrate his invention), nor that his conception was not the result of and the mere reflection of his theory. His theory was that a talking-telephone involved, as an indispensable element, a make and-break system (not the theoretical make-and-break of Professors Young and Brackett, but that which is palpable, perceptible). His conception of his invention responded to that theory, and his model was the materialization of that conception. His drawing and specification were in harmony with all three. So the circuit-breaker of McDonough's application is a key to the line of his investigation and the theory resulting from it. It indicates the source of his conception and the precise character of the invention upon which he predicates his claim to priority over Bell in this interference.

I recur again for a moment to the points before mentioned—to wit, that it is of no consequence what *theory* McDonough held if he in fact produced an invention which met the requirements of a speaking-telephone within the terms of the issue. Counsel proceeded to assert that McDonough did invent and construct a speaking-telephone, and that his models show it, and he refers to the evidence relied on to sustain his assertions. If McDonough, in the course of his experiments, did occasionally hear spoken words, was it because the instrument was made in accordance with his conception, as reflected in his application, drawing, and model, or because of an accidental condition not mentioned or demanded by the terms of his application? If a machine operating upon a different principle, and not in conformity to McDonough's conception, and at war with his theory, did occasionally talk, as asserted, it is clear that McDonough could not justly claim that such result was due to his theory, conception, or mechanical construction; and the cases cited by the learned counsel are in point, for in each of those cases the point is distinctly made that mere accidental use by a person is not conscious invention. He does not know that he has invented anything, and hence cannot know that he has anything to offer to others. *Colgate* v. *West. Un. Tel. Co.*, 15 Blatchf., 365; *Tilghman* v. *Proctor*, 102 U. S., 707.

Counsel says that it is not competent to hold that the McDonough device did not talk because it could not, and the Examiners-in-Chief erred in so doing, since that assumes the inoperativeness of a device upon which the Office has already passed. It will be observed, however, that the learned counsel argues with equal force that the device covered by the Bell patent is not an operative device, because it could not talk if constructed according to Bell's specification; and he says further, if Bell had died leaving to the world no other information touching a telephone than is contained in his application upon which his patent is predicated the public would never have heard of the Bell telephone, nor of Bell himself. The argument is legitimate, although the conclusion may be unauthorized.

The declaration of an interference is made on the assumption that the application or patent put in interference covers an operative device; but it by no means follows that such presumption is conclusive. It would border on the absurd to say that the moment the consideration of a vital question, important to both parties, and concerning that about which each has a right to be heard, is approached the hearing shall stop, and as to that important question the case should proceed *ex parte*. A motion to dissolve the interference is suggested as a proper proceeding, if the question of the operativeness of the device is raised in any manner or at any time. There is no reason why the question should not be raised and considered in determining that of priority. If the device of one of the parties is found to be inoperative, a dissolution of the interference would follow; at least the party having such device would have judgment against him.

It being competent to consider, as an item of evidence, the question of the operativeness of the McDonough device, or the device upon which he predicates his right to a patent as the prior inventor over Bell, I submit that I am not satisfied that McDonough had produced a speaking-telephone prior to Bell's successful efforts in the same field, and I am not satisfied that a telephone constructed in accordance with the specification of McDonough and operated in conformity to this theory and conception would or could transmit articulate speech within the terms of the issue.

I have considered the affidavits of Professors Young and Brackett in connection with the evidence given by them in the case of the American Bell Telephone Company *v.* the Overland Telephone Company of New Jersey. Taking the evidence of those two scientists as a whole, I cannot find that they have demonstrated or that they unqualifiedly affirm the fact to be that a telephone using the make-and-break system, as contemplated by McDonough, will transmit articulate speech within the terms of the issue. It transpires in the cross-examination of these learned gentlemen that they assume that a battery telephone-transmitter may successfully transmit articulate speech when it is operated to make and break alternately the circuit in a manner indicated by Silvanus Thompson, as quoted by counsel in the course of the examination of Professor Young in the case last cited. The breaks spoken of by Silvanus Thompson, however, are not those contemplated by McDonough—that is, such as will occur when all points on one electrode are removed from all points on the other electrode; but, on the contrary, are such as occur when a limited number of points on one electrode are removed from the limited number of points on the other electrode. Such breaks cannot cause an interruption of the current, because contact between the electrodes, as a whole, is not interrupted, and what Silvanus Thompson and Professor Young described as *breaks* are, in effect, nothing but variations of contact, which, when occurring between the electrodes of a telephone, will give rise to an undulated current. It is true that Professor Young does intimate that it is even possible that the character of make-and-break which they (he and Professor Brackett) have in mind may, instead of a hindrance, be a real advantage in the electrical transmission of articulate speech. The better and controlling opinion is that a telephone constructed on the make-and-break system according to McDonough's conception will not talk. If that is so, clearly McDonough cannot succeed in the contest with Bell; but beyond that, it will be remembered that every incentive to diligence, every suggestion of honor and profit, was prompting McDonough, and, in fact, all the parties to this contest, to make haste in giving to the public an operative telephone; every condition and circumstance that could influence human action in such a matter reprehended delay and inaction. These contestants were in the field, fame and fortune were waiting at the goal of success for the inventor who first reached that point with a speaking-telephone. Each contestant knew it; each was trying to secure the reward that waited on success. The record discloses what was done by each and the measure of success attained.

Bell's patent was issued on the 1st of March, 1876. At the Centennial Exposition, held at Philadelphia that year (1876), he exhibited his telephone, and it was adjudged by such eminent scientists as Professor Henry, Sir William Thomson, of England, Professor Gray, one of the contestants herein, to be a success, and the world recognized Bell as the first inventor of a speaking-telephone. The indications are that it was not until the promised reward for so important a public service became visible that his claim to priority was called in question by any of the parties to this interference.

When considering the facts disclosed in this case I am forcibly reminded of the observation of Justice Grier in the case of *Goodyear* v. *Day* (2 Wallace, Jr., 298):

> When genius and patient perseverance have at length succeeded, in spite of sneers and scoffs, in perfecting some valuable invention or discovery, how seldom is it followed by reward. Envy robs him of the honor, while speculators, swindlers, and pirates rob him of the profits. Every unsuccessful experimenter who did or who did not come very near making the discovery now claims it. Every one who can invent an improvement or vary its form claims a right to pirate the original discovery. We need not summon Morse or Blanchard or Woodworth to prove that this is the usual history of every great discovery or invention.

And to the same effect in the case of *Howe* v. *Underwood* (1 Fisher, 162) Justice Sprague said:

> How invariable it is that after a great invention has been brought before the world, has become known to the public, and put in a form to be useful, that people start up in various places and declare that they invented the same thing long before. * * These pretended prior inventors had thought of such a thing, perhaps, but they had never carried it to the extent of making it of practical utility, so that the world could obtain possession of it; but when they find that another has completed that which they had begun they are astonished that they did not see, think they must have seen all that is necessary, and claim that they have invented it. After having seen what has been done the mind is very apt to blend subsequent information with prior recollections and confuse them together. Prophecy after the event is easy prophecy. I think that this is one of the cases in which several of the witnesses have been led into the illusion of believing that they knew before what they have learned or been taught by Mr. Howe's invention and specification.

I quote further the language of the case of *Smith* v. *Fay & Co.* (6 Fisher, 452):

> The presumption arising from silence, where there is so much interest to assert and occasion to assert it, and the party intelligent, and the results certain if the facts warranted it, has far more strength than any preponderance in number of witnesses and literal statements made by them in the case.

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Also, *Hayden* v. *Suffolk Company* (4 Fisher, 101):

The greater the importance of the invention the less probable that if achieved it would have been laid aside and not extended itself to others interested in its use.

And, further, *Howe* v. *Underwood* (1 Fisher, 162):

It is a little remarkable that a perfect sewing machine * * * never produced work that anybody ever used for any purpose whatever; * * * that it was laid aside for years without producing either work or propagating itself in other machines ever after. *This is a phenomenon that requires to be accounted for.*

I have quoted these authorities which are cited in the brief of counsel for Bell, because the principle suggested and the ideas which are uppermost in the language quoted have had no little influence in bringing me to the conclusion I have reached in the determination of this case.

There is a disposition manifested by Bell's contestants to limit within the narrowest scope the invention claimed by Bell in his application of 1876, filed February 14th of that year. He then disclosed to the world what he had before invented—an art or method for transmitting articulate speech. His subsequent experiments demonstrated that the art or method discovered by him was what had been long sought, but not found, by his predecessors and rivals in the field of invention. He invented the art or method, and also an apparatus by which said art or method could be practiced. His claim as an inventor is for having done that thing in its entirety. The controlling issue in this contest is, however described and in howsoever many claims or subordinate issues it may find expression, a speaking-telephone. The invention of such a telephone involved necessarily the invention or discovery of the art or method not theretofore known of transmitting articulate speech. It would be impossible for an inventor to know that he had invented such an art until he had produced an apparatus which would enable him to practice it, for only by such a test could the fact be established. Hence it must appear that the inventor of the speaking-telephone must have invented the art and the apparatus, and I understand Bell's claim to cover the art and the apparatus by which he practiced said art. It occurs that Bell's competitors find in the various contrivances which they have invented certain elements which Bell now employs, and which they had employed in their unsuccessful efforts to transmit articulate speech. If not able to overthrow Bell's claim that he is the first inventor of a speaking-telephone, they seek to establish their claims to constituent elements, which they say Bell is not authorized to use without paying tribute to them. If they could succeed in this, it would be obvious, as counsel for Bell pertinently suggest, that these contestants will realize as great benefits from their several failures as Bell from his success. That all the efforts of the several contestants who had attempted to produce a speaking-telephone were failures seems clear from the record; that Bell was the first to give to the world the art of transmitting articulate speech, and the apparatus by which it could be successfully practiced, was substantially conceded for a long period after his success in that behalf was placed beyond doubt. Whether or not these several contestants had the instrumentalities and appliances at that time from which success might have been realized if those instrumentalities had been better understood is of little consequence. The history of their experiments is a history of recorded failures.

It is observed that Bell discovered, and his patent showed, that a certain combination of magnet, diaphragm, and armature, when arranged in a specified connection with other specified parts, constituted an apparatus which would transmit articulate speech. Up to this time no one else had done this, or had known it. The combination was the result of his conception and the outgrowth of his theory, and the apparatus, being a materialization of that conception and in conformity to that theory, was his original invention.

It is urged with great earnestness by counsel for McDonough that a telephone constructed after the manner shown in Bell's application would have been a failure, and would never have served as a valuable hint in constructing a commercial telephone, while he at the same time insists that McDonough has shown and described in his application a speaking-telephone. One very important truth may be mentioned in this connection, which goes a great way in resolving every doubt in favor of Bell as between him and McDonough. It is this: every improvement upon the Bell apparatus made in conformity to the specifications contained in Bell's original application tended to enhance the value of the telephone, and did, in fact, result in producing a thoroughly successful commercial instrument; while, on the other hand, every improvement of the McDonough device made in strict conformity to the requirements of his specification would tend to make the instrument worthless. The correctness of this proposition rests in large measure upon the theory that the underlying principle in the McDonough device was that it should operate by palpable make-and-break system, which involves a cessation of current at each vibration of the diaphragm. I am aware that this theory is assailed by the learned counsel for McDonough, and that he insists not only that the make-and-break is not incompatible with a successful speaking-telephone, but is in a measure a help. I accept the theory as fairly established that a telephone cannot be successfully operated which involves that system, and for the reason that there must be a time between the make-and-break when the diaphragm at the receiving end will not be under the control of the speaker, and will operate according to its own law.

The comments I have made touching the efforts of Voelker and McDonough apply with equal force, in the main, to those of the other parties in the contest with Bell. Edison is very properly accorded priority in issue D and No. 1.

A detailed review of each issue and each argument is not possible. I am satisfied from an examination of the evidence and consideration of the arguments submitted that the decision of the Board of Examiners-in-Chief should not be disturbed, and I do therefore approve and affirm it.

THE ELECTRIC LIGHT CONVENTION.

The convention of electric light representatives which met at Chicago on the 25th of February last, was peculiar, in that of all the people there assembled, to the number of 91 who registered on the secretary's book, not one could say definitely what the object of the gathering really was. So much of competition and jealousy has heretofore existed among the various interests, systems and manufacturers, to say nothing of inventors, that it was rather to be expected that some one had an ax to grind, in thus calling the various delegates together, and it was more than hinted at, that it was a little game in the interest of the "rowdy west," and probably Chicago, to do some awful thing to the Eastern gentlemen and their vested rights. Every right minded member of the convention however, came with a determination to sit down upon any "foul" which might become apparent, and the result was harmony and good feeling, from the first tap of the president's gavel, to the final close. It was evident from the "due form" of the presiding officer that he has somewhere wielded a gavel before he came to Chicago, and the justness of his ruling—albeit a little previous on one or two occasions—was satisfactory to all, and was evidenced in his unanimous election as president of the permanent organization. The amount of work done was far greater than could have been accomplished by a milder or less positive officer; and the success of the convention is largely attributable to his thoroughly business-like method.

The convention was called to order by W. A. Hovey, of the *Electrical Review*, who gave a short account of his fathering the idea of a convention, which had been prompted by that journal's correspondents. The morning session was short and was merely one of preliminary organization.

On convening at 2 P. M., the mayor of Chicago, Hon. Carter H. Harrison, was introduced and welcomed the delegates. He said that the impression prevailing abroad that Chicago did not want lights was an erroneous one. We wanted lights, but we wanted immunity from danger, both to life and property, and when these were guaranteed, Chicago would be to the fore in accepting and using them unstintedly. The convention had to deal with a monster, which it was for them to handle and render obedient, that it might not prove hurtful and mischievous. "The time was coming when bottled electricity would put a street car on wheels, and send it whirling to the suburbs, and also drive the elevated cars. In the name of Chicago I welcome you. Chicago is always ready to take in strangers."

Prof. Elisha Gray was introduced and made a short address. Among other suggestions he advocated the idea of the appointment of a sort of a "bureau of tribulation," with a secretary to whom all correspondence should be addressed, stating electrical and mechanical difficulties which might occur in the practical working of plants and machines, and that a record should be kept of the disease and the remedy, for the benefit of others. A delegate, who intended a still further elaboration of this idea failed to get his voice in, until after the permanent organization was effected, and as, under the constitution adopted he was excluded as ineligible, he failed to make his little speech.

The following officers were then chosen unanimously. President, J. F. Morrison, Baltimore; Vice-Presidents, H. M. Cleveland, Hartford, Conn., and J. H. Yarbrough, Nashville, Tenn.; Secretary, W. A. Hovey, New York. The Western Electric Co., through Mr. C. A. Brown, presented the president with a gavel representing a dynamo commutator, and trusted "that the convention in its deliberations will have as cohesive a number of segments," and the convention was declared in order for business.

The various suggestions which had been made by parties accepting invitations to the convention had been collated, and from these the committee appointed to formulate a list of themes for discussion, presented the following. 1. Incandescent lighting (particularly the distance from the dynamo at which they can profitably be run). 2. Locating and avoiding crosses with telephone wires. 3. Power and its conversion into light. 4. Electric light globes and shades. 5. Best modes of connecting dynamos with power. 6. Electric lighting by water-power. 7. Rates and rebates on electric lights by the year. 8. The use of electricity as applied to motors. 9. Where an electric light system requires No. 6 conductors, is it advisable to use Nos. 6 and

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4 on the same line? 10. Will armatures become affected by frost in transportation? 11. Special insulation or guards at dangerous points and places. 12. Best methods of street lighting. 13. Experience and results in the use of underground conductors. 14. *Resolved*: That the fireman should receive more pay than the engineer. 15. Help generally. 16. Experience with naked and copper-plated carbons.

By the time the above list of topics had been read, the delegates began to get an inkling of what they had come for, and to some extent appreciated the amount of labor laid out for the convention.

The first topic was temporarily passed. The second, interference with telephone lines, was made highly interesting by the reading of a letter from a telephone superintendent, who complained bitterly of the aggression of the electric light people. The discussion—pretty much one-sided, inasmuch as it was an electric light convention—was likely to become interminable, and was adroitly disposed of by reference to a committee, which subsequently reported succinctly that the best thing the telephone people could do was to get out of the way, and suggested that all aerial electric light wires should be run as near as was safe, both going and returning, upon the same pole or cross arm. A member stated that he had never known a dynamo very seriously injured by contact with a telephone wire. A member during the discussion related some facts relative to the distance which the electrical tramp—induction—affected a telephone, but the president squelched him, evidently considering him an emissary from the enemy, and Prof. Gray's remarks on induction fared but little better. In the course of the discussion Chicago, as a city opposed to electric lights, came in for a share of the scoring.

President Morrison temporarily vacated the chair and took the floor to speak on the subject-matter suggested in the letter, which had evidently aroused the liveliest interest in the convention. He had hoped that some one else would have taken up the matter without gloves, but he felt that there was no use in trimming all around the important interests which lay at the bottom of this vexatious controversy. Personally he was friendly to the telephone people, but he had no patience with obstructions and impediments to the electric light work which came from them, for they were based upon sheer prejudice against those who were laboring in the same field, although in a different part of it. This induction business was a bugbear and had always been a bugbear. It was rather cool for the telephone companies to call the electric light their "new neighbor." The light was a neighbor of considerable age, though he would admit that the methods of application were new, since the distributing companies were only about four or five years old. He knew of cities which, unlike the city of Chicago, not only wanted the electric light, but would have it. The people of those cities regarded the common use of the electric light as a necessity, and it was no longer any luxury with them. It is the old business of the telegraph and the telephone over again. When the telephone came along the telegraph people raised a big outcry, and now when the electric light followed, the telephone people seemed anxious to obstruct it as much as they possibly could. He could tell them that in Baltimore they ran the telephone and electric light wires side by side on both sides of the street, and recently the light company had given the telephone people a right of way side by side with their own wires. There was no trouble about it, either. That there was some induction was true; there was humming, and the crackling sound, like the noise of burning sticks under a boiling pot, but it had been proved that this noise, though a little annoying, made no difference with the sound of the human voice. The tones of the voice could be heard clearly and distinctly, and the telephone service was not impaired at all. The telephone people had made the same protests and objections in Baltimore, had written very long letters, and threatened all sorts of things. The letters had been carefully filed away, and they had been told that the electric light system had come to stay and that had ended the matter. The people wanted the telephone and they wanted the electric light also, and they were going to have both.

Mr. Haskins volunteered, as a matter of information, to detail a practical case, illustrative of the distance at which a dynamo would make itself heard in a telephone receiver. He stated that a dynamo running within an inclosure on one side of a street in Chicago, the wires of which were upon the face of the building, the width of the sidewalk, and at least 20 feet below some telephone lines, was distinctly heard on other wires on the farther side of the telephone exchange, by secondary induction. Mr. Haskins was immediately sat down upon by the president—who is no light weight—under the impression that an enemy was in the camp. An attempted explanation effected nothing, and the speaker sat down—squelched.

The discussion was participated in by Messrs. Wadsworth of the Boulton Carbon Co., Hovey, Fletcher of Dixon, Ill., Weeks of Kansas City, and others.

Power and its conversion into light, was thoroughly discussed. Ide, of Ide engine fame, told how the Springfield, Ill. plant was run, and Frank Stewart, of Chicago, contended for direct belting from engine to dynamo. Weeks, of Kansas City, concurred. Sperry, of Chicago, advocated thin belting, and objected to perpendicular belting as the tendency was to make the dynamo jump. The president stated that in New York geared wheels were used, and belting discarded. He considered larger and fewer engines profitable, rather than a greater number of smaller ones. He evidently considered friction clutches a delusion and a snare. They had tried several experiments in Baltimore, and had come down to tight and loose pulleys, and were now working without difficulty. Mr. Morrison's remarks were interlarded with much that was facetious, but all to the point and his statements were listened to with profound interest.

Electric lighting by water-power, called up George Fletcher, of Dixon, Ill., whose description of his plant created much merriment, and some astonishment, as well. He said he paid $15 a month for an engineer, and was asked by a member where he got him; to which he replied that the Lord made him, but he didn't come from Chicago. He bought carbons at $15, a thousand, and when asked if his lights were satisfactory to his patrons, he thought they were, but perhaps some of them didn't know. A member (*sotto voce*) "He probably lights a blind asylum." The carbon folks were exercised about the price of carbons, and in reply to their interrogatories, he stated that his carbons came from Buffalo. Mr. Fletcher is running 30 lights, and his engineer is one of his planing mill hands, whose duties in the mill permit of his assuming the other task, at a slight advance in salary, and his power is a turbine wheel which also does double duty.

Rates and rebates on lights was discussed by Randolph of Rockford, who said in winter they ran 15½ hours in stores, and had three circuits which he shut down at 7, 8, and 9 o'clock and charged accordingly. Much talk was indulged in, and finally by way of bringing the matter of this and the preceding topic to a head, the chair appointed a committee to prepare and report comparative estimates of the cost of erecting and running a plant of 100 lights by water and steam-power. This was a case of fat and fire. With terror depicted in his countenance and "lightning in his eye," a delegate rose to protest against such an un-business like procedure. In a move of this nature he saw the immediate downfall of the whole industry. It would give away to the world all the secrets of the business. By a vote of the convention the committee was discharged on the spot.

Electricity as a motor was discussed by Mr. Hovey, who said that the question was now near the end of the experimental stage, and ready to be taken from the laboratory and placed on duty. Scientists, like Edison, were not practical men. Mechanics must now take hold of the question, to make the discoveries of the former class of workers available, and complete the work they had begun, and some one must lose money before this could be satisfactorily accomplished. Mr. Van Depoele, of Chicago, said the power of a motor could be controlled as well as could that of a steam engine. Mr. Sperry, of Chicago, advocated small motors to take the place of electric lights in seasons when these were not needed, to run fans for ventilating apartments, and so keep the plant alive the year through. Mr. Hochhausen, of New York, gave some information relative to European railways operated by motors, and said the Cleveland, O. street railway was the only one running in this country. Mr. Wadsworth of Cleveland had seen one in Boston. The doctrine of probabilities, or as it was termed "the law of average," here became the topic, apropos of the statement of a member that a large number of small motors, each of which would be compelled to remain idle during the shifting and preparing of its work, as in the case of machinists and turners, lathes, sewing machines, and the like. It was argued that this loss would be a gain to the party furnishing power, inasmuch as more power could be thus sold than was actually furnished. The president and several of the delegates were too conscientious to endorse the proposition. Banks which loan their deposits, telephone companies who cannot serve all their customers at once, gas and water companies, which could not possibly give a day's supply, if every customer was to draw on them at the same time, were cited as instances of similar scientific guess-work bases, but to no avail. The president and his honest followers were like Banquo's ghost—they would not down.

The next topic was the result of an inquiry from some one who had a circuit of No. 6 gauge wire, and wanted to extend it by the use of some No. 4 which he had, and the convention decided that he might. The convention then adjourned till 10 A. M., Feb. 27.

On re-convening, the president announced the topic "special insulation, or guards to insulation of lines at dangerous points and places," and called upon Mr. Haskins, of Chicago. Mr. H. detailed his ideas of insulation, and related his experience with underground terminals, explaining the spread of moisture, as I have mentioned in another portion of this letter. He also gave the results of experiments undertaken with a view of ascertaining the safest relative distance between positive and negative wires in the incandescent systems, in which he showed conclusively that the nearer together they are the better, where safety strips are used. These were given in full, in the February number of the ELECTRICIAN AND ELECTRICAL ENGINEER. Specific cases were referred to Mr. H., who prescribed for the symptoms given. Mr. Place, of Chicago, also talked high insulation.

"Will armatures become affected by frost in transportation?"

Mr. Van Depoele said he had examined one case, and the result

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showed that the dynamo had been burned by being wrongly connected up, and the user had charged frost with the mischief. A case was mentioned where a dynamo was frosted in transit between St. Paul and Minneapolis, and the president (a Brush man) said it was probably a poor form of dynamo.

A delegate—"It was a Brush dynamo," and for once the presiding officer was staggered; but he did finally recover sufficiently during the thunder of applause, to remark in a faint whisper, "then there was something else the matter." The question was very decidedly negatived.

"Street lighting," and how best to do it was thoroughly discussed by advocates of the tower system and its opponents, the general impression prevailing that the former was adapted for smaller, and the pole system for larger communities.

Then the knotty question of how long a circuit can an incandescent system be made to operate satisfactorily, brought out much talk, but elicited little information. The question was apparently no easier of solution than that of the semi-idiotic child, who pulled at his mother's skirt, and asked, "Maw! Maw! How fast can a cow run up an alley a minute?" It was too much for the convention, which at once adjourned until 2 P. M.

Underground circuits could not well be handled satisfactorily, under the shadow of the Chicago "ground hog" ordinance, and that question was tabled.

The next topic was—"*Resolved*, that the fireman should receive more pay than the engineer." There was no one to advocate the affirmative, and the fireman's sun of glory did not rise.

The telephone trouble committee then reported, as I have abridged it above, encouraging the lesser lights to run metallic circuits, and use lightning arresters, etc. A remark by a member unheard generally, suggested the propriety of these troubled people keeping out of the way of the procession.

The carbon people had a benefit on the next topic. Much difference of opinion was expressed as to the relative value of the plain and copper-plated carbons. Mr. Wadsworth stated that the Boulton company was about to cease the coppering process. From the difference of opinion expressed it is evident that the matter is not yet sufficiently sifted to form proper conclusions. Mr. Arey, of the Buffalo works—he's the $15, a thousand fellow—gave as the measurement of a standard carbon $\frac{3}{10}$ of an ohm resistance, "for what it is worth."

The committee on permanent organization then reported, the result of which was the adoption of a constitution by "The National Electric Light Association," to which all companies, firms or individuals operating plants or manufacturing apparatus, are admitted on payment of an initiation fee of $10, and $10 annual dues. Outside parties connected with electric lighting, other than those owning or operating plants—the line of demarcation is not quite definite—may become associate members, with limited rights, at the same price; but like the steam dredge, which Paddy saw at work, "can't vote." An executive committee is the governing body, to be elected annually. The following officers provided for by the constitution, were then unanimously elected, to hold their positions for one year, or until the next election, President, J. F. Morrison, Baltimore, Md.; Vice-Presidents, H. W. Cleveland, Hartford, Conn.; E. R. Weeks, Kansas City, Mo.; J. H. Yarbrough, Nashville, Tenn.; Secretary and Treasurer, W. A. Hovey, New York (*Electrical Review*); Executive Committee, J. R. Fletcher, Dayton, O.; G. S. Bowen, Chicago, Ill.; W. Hochhausen, New York; Gilbert Donaldson, St. Paul, Minn.; Frank Ridlon, Boston, Mass.; James O'Connor, New Orleans, La.

In accepting the position of permanent president, Mr. Morrison gave the association many practical suggestions as to the possibilities of the organization, and the duty and responsibility of each member. All must do their part, and if each would bring to the next meeting of the association a record of the successes and trials of the year, the association would arrange all these various experiences in a tangible form for the benefit of all, and an immense good would result from this form of record and its dissemination. Enough had been done to show that this was practical, and taken as a whole, he considered the beginning which they had made a full guarantee of success.

Votes of thanks were tendered to the Grand Pacific proprietors and the press of the city, and at half-past three the convention adjourned to meet at Saratoga in July next, on notice from the secretary.

I look upon the convention as a grand success. The following is a list of those who recorded their names on the secretary's book.

J. F. Morrison; Sommerfield Baldwin, Brush Electric Co., Baltimore; Theo. P. Bailey, Chicago; A. N. Lane, Muskegon, Iowa; R. M. Johnson, Hyde Park, Ill.; J. H. Yarbrough, Nashville; R. T. Robinson, Providence; A. L. Ide, Springfield, Ill.; H. M. Cleveland, Schuyler Electric Light Co., Hartford; S. E. Locke, Schuyler Electric Light Co., Omaha; S. S. Badger, Badger Electric Light Co., Chicago; M. C. Bullock, Brush Electric Light Co., Chicago; C. J. Richards, Racine, Wis.; F. S. Terry, Electrical Supply Co., Chicago; J. H. Reid, Electrical Supply Co., Chicago; W. L. Bush, Van Depoele Co., Chicago; C. J. Van Depoele, Van Depoele Co., Chicago; E. J. O'Beirne, Star Iron Tower Co., Ft. Wayne, Ind.; W. A. Knapp, Railway Telegraph Supply Co., Chicago; W. T. Lewis, Thomson-Houston Co., Racine, Wis.; F. H. Angell, American Electrical Works, Providence; C. C. Curtis, Brush Co., Cleveland; E. D. Libbey, New England Glass Co., Boston; J. D. Robinson, New England Glass Co., Chicago; Geo. D. Fletcher, Van Depoele Co., Dixon, Ill.; Elmer A. Sperry, Sperry Electric Light Co., Chicago; Edwin Place, Sperry Electric Light Co., Chicago; Chas. E. French, Cleveland Carbon Co., Cleveland; R. J. Randolph, Rockford, Ill.; W. T. Powers, Grand Rapids Electric Light Co., Grand Rapids, Mich.; Geo. W. Carter, Van Depoele Co, Jackson, Mich.; E. T. Keim, United States Electric Light and Power Co., Dubuque, Iowa; C. B. Askew, St. Paul Electric Works, St Paul; Joseph Fleisheim, Electric Light Co., Menomonee, Mich.; Geo L. Crossman, Thomson-Houston Electric Light Co.: D. Jacobus, Van Depoele Co., Crookston, Minn.; E. M. Fox, E. Remington & Sons, Ilion, N. Y.; F. M. Mills, Thomson-Houston Co., Des Moines, Iowa; E. R. Montague, Brush Co., La Crosse, Wis.; H. C. Adams, Holmes, Booth & Haydens, N. Y.; A. W. McLaughlin, Boston; R. L. McDonald, Jenney Electric Co., Ft. Wayne, Ind.; Vernon Bell, Western Electric Co., Minneapolis, Minn.; Harold P. Brown, Chicago; Wm. H. Beach, Olmstead Electric Light Co, Minneapolis; T. P. Plumridge, American Carbon Co., Chicago; W. M. Goldthwaite, Electric Light Co., La Porte, Ind.; W. M. Goldthwaite, Electric Light Co., Adrian, Mich.; Albert L. Arey, Buffalo Electric Works, Buffalo; H. D. Stanley, Bridgeport Electric Light Co., Bridgeport, Conn.; Wm. A. Hovey, *Electrical Review*, New York; Charles W. Price, *Electrical Review*, Chicago; G. W. Parker, Parker-Russell Manufacturing Co., St. Louis; L. M. Fishback, Parker-Russell Manufacturing Co., St. Louis; W. Hochhausen, New York; John C. Fyfe, Nee Bau Electric Light Co., Chicago; W. A. Hammett, N. Y. Safety Steam Power Co., Chicago; Frank Stewart, Western Electric Co., Chicago; Chas. A. Brown, Western Electric Co., Chicago; George S. Bowen, Elgin Electric Light Co., Elgin, Ill.; W. H. Boulton and Geo. H. Wadsworth, Boulton Carbon Co., Cleveland, O.; E. R. Weeks, Thomson-Houston Electric Light Co., Kansas City, Mo.; Aaron K. Stiles, Van Depoele Co., Chicago; W. A. Kreidler, Correspondent, Chicago; Frank Ridlon, Brush Electric Light Co., Boston; R. T. McDonald, Jenney Electric Light Co., Ft. Wayne, Ind.; C. C. Warren, U. S. Electric Light Co., Chicago; W. J. Buckley, Excelsior Electric Light Co., Chicago; E. M. Barton, John Young, Western Electric Co., Chicago; C. C. Haskins, Chicago, C. A. Cotter, Ansonia Brass and Copper Co., Chicago; W. P. Hathaway, Fuller Electric Light Co., Milwaukee; W. F. Walworth and J. C. Neville, Manufacturing Electric Light Crossarms, South Bend, Ind.; E. B. Palmer, Sperry Electric Light Co., Chicago; H. L. Brintnell, Swift Electric Light Co., Saginaw, Mich.; J. H. Stanwood, Badger Electric Light Co., Chicago; L. W. Slack, Pittsburg Carbon Co., Pittsburg, Pa.; Elisha Gray, Chicago; H. W. Burgett, American Electrical and Illuminating Co., Boston; Gilbert Donaldson, Electric Light Co., St Paul; W. H. Keasel, Willoughby, Hill & Co., Chicago; D. R. Russell, Parker, Russell & Co., St. Louis; John R. Fletcher, Dayton Electric Light Co., Dayton, Ohio; C. H. Webster, Chicago; J. D. Simpson, Chicago.

CONVENTION NOTES.

A proposition was made by the president between meetings to "kill Haskins, and tear the word insulation out of the dictionary," and then he thought the electric light folks would have peace.

One member of the convention said that the reason he came was because he had received a circular from the company whose system he was using, advising him to stay away from the convention, and so he came for spite! Probably like the minister who visited a disreputable performance, so he could the better warn his flock from personal experience. That same company however, was represented by its chief inventor.

In conversation, between the acts, the telephone matter came up, and one member said that when he found himself in front of a procession, he generally took to the steps or the gutter; and he thought the old rule of the rail applicable to the telephone folks:

The rule of the rail; soon come or soon go,
Admitting of little delay;
If you go, get in quick—you are left if your'e slow,
Get out, and get out of the way.

A few of the members had a private session, on the night of the first day, which lasted well into the morning. Several were quite weary with their artistic efforts at coloring the town.

CHICAGO, March 4, 1885.

DEATH OF GENERAL STAGER.

Gen. Anson Stager died at his home in Chicago, at 3 o'clock A. M., March 26th. He was born in Ontario County, N. Y., April 20th 1825. His father was a manufacturer of edge tools at Rochester, N. Y. When 16 years of age he engaged in printing under the instruction of Henry O'Reilly, who afterward became a pioneer in the building and operating of telegraphs. O'Reilly

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induced young Stager to follow him into this undeveloped enterprise, and when he had connected Philadelphia with Harrisburg the young man took charge of his first office at Lancaster, on this line, in the fall of 1846. He soon became an expert telegrapher, and in the extension of the lines west of the Alleghany mountains, he was transferred to Pittsburg. As the lines were carried westward through the Ohio and Mississippi valleys, this became an important station, and in its management the young man first gave evidence of the extraordinary administrative abilities which characterized his subsequent career. It may be mentioned that among the messenger boys in the Pittsburg office under Stager's administration were some who have since risen to high positions, among whom may be mentioned Andrew Carnegie, the great iron manufacturer, Robert Pitcairn, of the Pennsylvania railroad, and D. C. McCargo, of the Pennsylvania company. It was not long however before Cincinnati became the controlling point of the western telegraphic system, and he was placed in charge of that station, which soon acquired the well-deserved distinction of "the model telegraph station of America."

While at Cincinnati, he was employed at frequent intervals during the years 1848–'50, in making determinations of longitudes, "wave time" of electric currents, etc., for the U. S. Coast Survey under the direction of the late Prof. Sears C. Walker, in which important service he won new laurels.

While still acting at Cincinnati, the New York and Mississippi Valley company's lines, connecting Buffalo, N. Y. with Louisville, Ky., were projected, and Anson Stager was made the first general superintendent thereof in 1852. In July of the same year, through the absorption of the New York State Printing Telegraph Co.'s lines by the Mississippi Valley Printing Telegraph Co., Gen. Stager's supervision was extended over that state. Soon after this he was prominent in organizing the various lines and interests leased by and consolidated with the Western Union Telegraph Co., and upon the organization of that company he became its general superintendent. The extensive and elaborate system of railroad telegraphs in use on all the railroads in the west and northwest owes its origin to him. On one of Gen. Stager's many trips in the interests of his company an engine on the Pittsburg, Fort Wayne and Chicago Railroad broke down at night, nine miles from an office. Stager cut the wire and by touching the ends telegraphed to Pittsburg and Brighton for another engine. By fixing one end of the line above and the other beneath his tongue, the electric pulsations could be felt, and he thus received reply that another engine would be sent at once. This feat, then a novel one in telegraphy, gave him a wide celebrity, both in this country and abroad.

When Sumter was fired on the Governors of Ohio, Indiana and Illinois took possession of the wires in those states for military purposes and at once put Gen. Stager in charge of them as representing themselves. He accompanied Gen. McClellan in his West Virginia campaign, during which he established the first system of field telegraphs used during the rebellion. When Gen. McClellan was transferred to Washington he called Mr. Stager to that department to organize the military telegraph. This he accomplished, and remained in charge until November, 1861, when he was commissioned captain and assistant quartermaster, and, by order of the Secretary of War, was appointed Chief of the United States Military Telegraph throughout the country. Subsequently he was commissioned colonel and aide-de-camp, and was also placed in charge of the cipher correspondence of the Secretary of War. The cryptography used in this correspondence all through the war, which baffled the most persistent efforts of the rebel telegraphers and officers to translate, was in all its details his. Col. Stager remained in the service until September, 1865, and was breveted brigadier-general for valuable and meritorious services.

Following the close of the war, the consolidation of the Southwestern and American Telegraph companies with the Western Union made necessary a reorganization of the latter, and the general superintendency of the consolidated company was offered to, but declined by, Gen. Stager. A result was the creation of three grand divisions—the central, eastern and southern, Gen. Stager accepting the superintendency of the central, which left him in charge of his old territory, with headquarters at Cleveland. Four years later Cleveland became no longer a central point, and during the summer of 1869 the headquarters were transferred to Chicago. After coming to Chicago he became the leading western representative of the Vanderbilt interests. He founded the Western Electric Manufacturing Co., the largest manufactory of electrical machinery in the United States, and continued to be its president until Jan. 1st of the present year. Gen. Stager has been prominently identified with the development of the telephone business in Chicago and the northwest. He also took a prominent part in the introduction of the electric light, and has been the president of the Western Edison Electric Light Co. since its formation. Railroads also received a great deal of attention at his hands. Gen. Stager was married Nov. 14, 1847, to Miss Rebecca Sprague, of Buffalo. He lost his wife Nov. 22, 1883. Of his children only three are living—Mrs. F. S. Gorton, Mrs. Ralph W. Hicks, and Miss Ellen Sprague Stager.

FINANCIAL STATEMENT OF THE AMERICAN BELL TELEPHONE CO.

THE American Bell company issues the following statement of operations for ten months ended December 31, compared with 12 months ended Feb. 28, 1884. This is caused by a change in the financial year from Feb. 28 to Dec. 31 :

Earnings.	1883–4. (12 months.)	1884. (10 months.)
Rental of telephones	$1,695,678.58	$1,635,848.64
Sales of instruments and supplies	17,969.59	5,803.55
Royalty from manufacturers	4,837.74	....
Dividends	440,923.00	317,887.20
Commission from extra-territorial and branch lines	45,819.68	58,109.75
Commission from telegraph business	12,305.81	11,290.10
Interest	78,059.67	38,604 73
Totals	$2,295,594.07	$2,067,543.97
Expenses.		
Expenses of operation	$172,909.69	$198,553.59
Legal expenses	129,893.22	124,809.25
Interest and taxes	125,882.89	33,710.25
Depreciation	24,120.69	98.24
Commission	354,856.21	325,207.19
Royalty	12,500.00	10,000.00
Totals	$820,162.70	$687,378.52
Net earnings	$1,475,431.37	$1,380,165.45
Balance of income from previous year	168,081.54	348,884.17
Miscellaneous items to surplus account	91,291.87	34,918.45
Totals	$1,734,804.78	$1,763,968.07
Dividends declared	$1,051,479.00	$1,152,252.00
Extra dividend Dec. 15, 1884	....	288,063.00
Carried to surplus account	334,441.61.	323,653.07
Balance to income account	348,884.17	....
Totals	$1,734,804.78	$1,763,968.07

The assets and liabilities December 31, 1884, were :

Assets.		
Telephones	$558.319.51	....
Stocks	22,125,173.36	....
Merchandise and machinery	18,851.28	....
Lines	102,270.55	....
Bills and accounts receivable	681,493.74	....
Cash and deposits	520,536.33	....
Liabilities.		
Capital stock	....	$9,602,100.00
Loan of 1882 (convertible)	....	3,600.00
Bills and accounts payable*	....	516,935.81
Patent account (profit and loss)	....	9,540,120.31
Profit and loss	....	3.225,478.63
Reserve	....	61,297.59
Surplus	....	1,057,112.43
Total	$24,006,644.77	$24,006,644.77

*Of this amount $288,063 is the dividend payable January 15, 1885, to stockholders of record December 31, 1884.

NO PAY, NO WORK.

The new Receiver of the Bankers and Merchants' Telegraph Co., exhibited his profound knowledge of the labor question by issuing the following circular, on March 19th, which was bulletined in the main operating room, at 187 Broadway :—

To Employés: Appreciating fully the hardship to which the employés of this company have been subjected by reason of the failure to pay promptly the amount due, I have made a vigorous effort since becoming Receiver to secure advances in money sufficient to make a settlement of all outstanding labor debts from the 23d day of September, 1884, to the 1st day of March, 1885. My efforts have been so far successful that parties stand willing to advance me a sum sufficient to pay at once 70 per cent. of all claims of the class above mentioned within the above period, provided this sum shall be accepted in full settlement of the same. Notify me without delay whether it is acceptable to you. If the proposition is accepted, I contemplate paying hereafter all future claims for services promptly on the 10th day of each month.

When the night force went on duty they complied at once with Mr. Butler's request, to notify him without delay whether the terms were acceptable. A despatch was sent to that gentleman, at the Hoffman House, to the effect that unless the operators were assured by nine o'clock, that the money due them would be paid in full, they would leave their keys at that hour.

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Receiver Butler appeared at the office personally at 8.45, P.M. He narrated the old plea of incoming administrations under such circumstances, that the treasury was empty; but that he had borrowed sufficient money to pay 70 per cent. of their claims, if they would sign receipts in full. Different propositions were made by each party, but the operators insisted upon the payments for February being made on the following day, and in full, according to their regular schedule. Mr. Butler not feeling confident that he could carry out the promise if made, refused to compromise himself, and accordingly, at nine o'clock 20 men put on their coats and left the office, leaving the manager and two chief operators on duty. Mr. Butler, it is said, was highly indignant at the stand taken by the men, and made the usual assertion, that the business could be done without them. If such was the case, there appears to have been no real foundation for his wrath. The force in the Boston office expressed their sympathy with the New York operators by following their example, although it is understood that they had no personal reasons for complaint. Quite a number of operators also suspended work in other cities. In consultation with a committee of the employés on the following morning, Mr. Butler agreed that the February arrearages should be paid on March 21st, and that thereafter payments would be made as regularly as possible. The men then assumed their duties, and, for the present, no more difficulty of this kind is apprehended.

PROGRESS OF INCANDESCENT LIGHTING IN THE UNITED STATES.

The following isolated plants have been recently introduced by the United States Electric Lighting Co., or are now in process of construction :—

Washington Building, N. Y., 900 lights; New York Post-Office, 1,200 lights; Frank Leslie's, N. Y., 200 lights; Union Ferry Co. (two new boats), 150 lights; Pennsylvania R. R. Station, Jersey City, 600 lights; Smith, Gray & Co., Brooklyn, 160 lights; Palmer House Barber Shop, Chicago, 300 lights; Royal Insurance Co., Chicago, 1,155 lights; Home Insurance Co., Chicago, 1,500 lights; U. S. Custom House and Post-Office at Chicago, 750 lights; do. Cincinnati, 800 lights; do. St. Louis, 750 lights; U. S. steel cruiser, Atlanta, 200 lights; Las Vegas Hot Springs Co., Hotel, New Mexico, 652 lights; Geo. H. Friend & Son, W. Carrollton, Ohio, 60 lights; College of Ottawa, Ottawa, Ont., 100 lights; New York & Phila. & N. R. R. Co., steamer Cape Charles, 75 lights; Middlings Purifier Co., Jackson, Miss., 250 lights; Nashville Cotton Co., Nashville, Tenn., 250 lights; P. Espinal, Theatre, Caracas, Venzuela, 500 lights; Battle House, Mobile, Ala., 200 lights; Fred. Hauson, Hotel au Claire, Wisconsin, 100 lights; Samuel Cupples's, Factory, St. Louis, Mo., 150 lamps; Huron Mills, Ypsilanti, Mich, 150 lights; U. S. Post-office, Philadelphia, Penn., 600 lights; E. W. Hydorn & Son, Troy, N. Y., 690 lights; A. S. Turner, Elmira, N. Y., 575 lights; Mortimer Building, New York, 100 lights; Hamilton Club, Brooklyn, 300 lights; Mutual Life Insurance Co., new building, New York, 750 lights. This last plant has been substituted for a large installation of Sawyer & Man lamps which has been in operation for lighting the building for some time past, but has been rejected as unsatisfactory, and the Weston incandescent system substituted for it.

DEATH OF SIR CURTIS LAMPSON.

A despatch from London, March 13, announced the death of Sir Curtis Miranda Lampson. He was born in Vermont, September 21, 1806, and in 1830 went to England, where he was naturalized in 1848. When the company was formed for laying the Atlantic cable in 1856 he was made one of the Board of Directors and became vice-chairman. His important services in this great enterprise were acknowledged in a letter from Lord Derby to Sir Stafford Northcote, who presided at the banquet given in Liverpool, October 1, 1866, in honor of those gentlemen who had taken an active part in the laying of the cable. He was made a baronet November 13, 1866. He was Deputy Governor of the Hudson Bay Company and was one of the Trustees of the Peabody fund.

AN ELECTRIC RAILWAY IN MARYLAND.

The *Maryland Journal* says :—The Union Passenger Railway Co., of Baltimore, has commenced the building of a branch connection to Mt. Vernon, Hampden and Woodbury, in which electricity will figure as the motive power. The electric conductor will be a third rail laid in the centre of the regular rails. The cars will be drawn by motors with electric machinery. The contact between the electric rail and the motor is by a wheel, which runs over the rail, picking up the electricity. A motor, independent of the cars, is being made to try the experiment, and if it is successful, it is likely that the future motors will be part of the cars, so that one man may run the motor and act as collector of fares too. It is claimed for the new system that it will be cheaper than horses; that there will be no noise, no smoke and no cinders, and that it will make from eight to ten miles an hour. The pressing of a finger against a button is all that is required to manage the motors. General superintendent Robbins says that if the experiment turns out all right on this branch road, with its steep grades, the system will work satisfactory anywhere. The length of the new road is two miles and a quarter, and it is expected to be ready for use about the middle of April.

INCANDESCENT LAMPS IN ENGLAND.

We are informed on good authority that the output of incandescent lamps in England, at the present time, is in the neighborhood of 20,000 per week. Of this number about 13,000 are manufactured by the Swan company, who find it difficult even at this rate to keep up with their orders. Woodhouse and Rawson are making about 4,000, and the Victoria company about 2,000, the balance being the product of several of the smaller establishments. This appears to be largely in excess of the production in the United States.

THE TELEPHONE WAR IN CANADA.

A despatch from Montreal, March 19th, says the Dominion Telephone Co. having been successful in proceedings before the Minister of Agriculture against the Bell Telephone Co., and having obtained the annulment of the Bell patent, have to-day instituted similar proceedings for the annulling of the Blake, Phelps. Anders, and Edison patents. The Bell company, after a long fight in the United States, acquired these patents. A petition has been drawn up on behalf of the Dominion company and will be presented to the Minister of Agriculture in a few days. It is held by the Dominion company that the Bell company do not manufacture their instruments here, that they have all along imported them into the country, and have refused to sell the patent to any one, thereby forfeiting their rights and privileges under the act.

THE NEW YORK ELECTRICAL SOCIETY.

At the regular meeting held March 11th the following officers were elected for the ensuing year :

President—P. H. Van Der Weyde. *Vice-Presidents*—George B. Scott, George A. Hamilton, T. A. Edison, W. J. Johnston, C. O. Mailloux and George Worthington. *Treasurer*—F. W. Jones. *Recording Secretary*, A. A. Knudson. *Executive Committee*—P. H. Van Der Weyde, George B. Scott, F. W. Jones, E. L. Bradley, J. A. Seely, H. A. Sinclair, Eugene Lynch, Jr., John M. Pendleton, A. A. Knudson.

WESTERN UNION EARNINGS.

The following is the financial report issued by the Western Union Telegraph Co. for the quarter ending March 31, 1885 :

The net revenues for the quarter ending December 31 were reported at $1,415,846.71, which, added to $4,159,190.57, the previously reported surplus, gave the company $5,575,037.28. Appropriations for dividend, interest on bonds and sinking funds reduced this amount to $4,231,667.06, which was the surplus reported to be on hand January 1, 1885. The statement for the present quarter is as follows :

Net revenues based upon nearly completed returns for January, partial returns for February, and estimating the business for March		$1,350,000 00
Add surplus January 1		4,231,667 06
Total		$5,581,667 06
Interest on bonded debt	$123,500	
Sinking funds	20,000—	143,500 00
Balance		5,438,167 06
Dividend of 1⅛ per cent. on the capital stock		1,199,835 00
Deducting which leaves a surplus, after paying dividend, of		$4,238,332 06

TELEPHONY ON UNDERGROUND WIRES.

Dr. Jacques, electrician of the Bell Telephone Co., has carefully investigated the problem of telephonic transmission upon underground wires, and finds the results to be satisfactory so long as the product of the electrostatic capacity of the circuit in microfarads when multiplied into its resistance in ohms does not exceed 18.000. When this product exceeds 30.000, the articulation is entirely unintelligible. With an insulated conductor like that of the average submarine cable, having, per knot, a resistance of 11.5 ohms and a capacity of 280 mf., the limit of good speaking would be about 6 miles, and of intelligible speaking about 10 miles.

ELECTRIC LIGHT AND POWER.

Domestic.

Electric light companies have been formed in Columbia and Lancaster, Penn.

A new stock company is soon to be formed at Chicago for the purpose of manufacturing a new system for operating incandescent electric lights, invented by Harold P. Brown, electrical engineer. The incorporators of the proposed company comprise prominent capitalists of Chicago and Boston.

The East Cleveland street railway company of Cleveland, O. is completing arrangements for running the cars of the Euclid avenue, Cedar avenue and Garden street lines with electricity, on the Knight-Bentley system. For the present the new system will be applied to that portion of the lines running east of their re-

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spective stables. A new building will probably be erected at the Cedar avenue stables for engines, boilers and dynamos. The trial of their experimental car on the Garden street line during the winter months seems to have been fairly satisfactory. It is expected to have the new plant in operation inside of three months.

Foreign.

The Manchester *Mechanical World* says: We are glad to notice the steady increase there is in the number of corn mills being lighted with the incandescent lamp. Messrs. Sugden and Sons, of Brighouse, have recently lighted one of their Brighouse mills; their mill at Shorefoot, Huddersfield, has been lighted for some time. The dynamos are driven from the main machinery, and no irregularity or "pulsation" in the light has been observed. The number of lights required for a good-sized corn mill is about 60, and the light given is found greatly superior to the old plan of oil lamps and candles. But the greatest and most important advantage in the incandescent lamp is in its perfect immunity from causing any explosion. A large number of corn mills have been fitted up in Ireland, and if it were not for the great depression in the corn, etc., trade, there would not be any important mill without the "electric light."

The first electric railway opened in the United Kingdom was that between Portrush and the Causeway. Ireland will soon possess a second line. The Bessbrook Spinning Co., are constructing at their own expense a tram-way from Bessbrook to Newry. It will be opened in a few weeks.

The Hammond Electric Light and Power Supply Co., is to light some of the leading thoroughfares of London, and is to have the privilege of opening roads for private lighting without special Act of Parliament. This is the first substantial triumph of the electric light in the metropolis.

The Colchester (England) electric light installation of the South-eastern Brush company, the only central station system in England, will doubtless suspend operations owing to lack of financial support.

MISCELLANEOUS.

The Society of Telegraph Engineers and Electricians, founded in London, in 1871, under the name of the Society of Telegraph Engineers has to-day 1,256 members, of whom 369 are active, 179 are foreign, 668 are associates, 37 students, and 3 honorary.

During the year 1884 the Underwriters' Fire Patrol of San Francisco responded to 239 bell alarms, 33 still and 47 telephone alarms of which 15 were false.

MANUFACTURING AND TRADE NOTES.

Pope, Cole and Co., proprietors of the Baltimore Copper Works, have suspended. They have for several years past been extensive manufacturers of blue vitriol, supplying the Western Union Telegraph Co., and other large consumers.

The Buckeye Engine Co., Salem, O., is completing an order for five 50 h. p. self-contained steam engines for the Municipal Electric Light Co., Brooklyn, N. Y., and one for Oswego, N. Y.

The Excelsior Electric Apparatus Co., No. 61 Nassau street, is selling the new electric lamp scarf pin with battery, for which a patent was recently granted to Mr. A. Haid.

THE TELEGRAPH.

The office of the Bankers and Merchants' Telegraph Co. in Paterson is closed, and a paper pasted on the door declares that the landlord seized on all the effects of the company in Paterson for two months' back rent for the office.

The Baltimore and Ohio Telegraph Co., opened for business at York, Pa., on March 3d, the line from Baltimore (60 miles) having been constructed within 14 days, during which time the thermometer was usually below zero.

The directors of the Baltimore and Ohio Railroad Co. have adopted a resolution ratifying and confirming all previous action of the executive officers in regard to the expenditures required for the extension of the Baltimore and Ohio telegraph system.

The new line of the Baltimore and Ohio company has been completed to New Orleans.

Daniel S. Robeson, a stockholder in the American Rapid Telegraph Co., in behalf of himself and other stockholders similarly situated, has filed a bill in equity in the United States Circuit Court at Boston, against the company, Anthony W. Dimock, and others, charging that the defendants have made undue preferences and created liens on the property and assets of the company in favor of the Bankers and Merchants' Telegraph Co., and asks for an accounting between the two companies and the appointment of a Receiver of the American Rapid Telegraph Co. A restraining order has been issued by the court.

The Eastern Union Telegraph Co., at their annual meeting, held at Greenpoint, elected the following officers for the ensuing year: president, John B. Young; superintendent, W. F. Hammond; secretary and treasurer, William H. Wiggins. A dividend of 22 per cent. was declared.

THE TELEPHONE.

At the annual meeting of the Bell Telephone Co., of Philadelphia, the present directors were re-elected. Henry Bentley was also re-elected president, with Dr. S. M. Plush, general manager, A. A. Ziegler, treasurer, and George W. Snyder, superintendent.

The directors of the Erie Telegraph and Telephone Co., have accepted the resignation of W. A. Ingham as president, and filled the vacancy by the election of James W. Bennett.

Judge Wallace has issued a preliminary injunction restraining the Baxter Telephone and Telegraph Co., of central New York, from conducting a telephone business. This is a sub-company of the Baxter-Overland doing business at Utica. There was a company using the Bell patents there, and the Baxter-Overland came in as a competitor.

There were sold at auction March 11th, 900 shares Molecular Telephone Co. ($100) at 6, 250 shares Molecular District Telegraph and Telephone Co. ($25) at 5, 700 shares Harlem District Telegraph Co. ($10) $400 for the lot.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 59 *Wall Street*, *New York city*.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From February 24, to March 17, 1885 (inclusive).

Alarms and Signals:—*Fire Alarm Signal Box*, J. Young, 313,040, Feb. 24. *Thermostat*, F. H. Prentiss and J. A. Tilden, 313,523, March 10. *Messenger Signal and Fire Alarm Apparatus*, J. J. O'Neill, 313,610. *Automatic Signal Controlling Apparatus*, E. R. Gill, 313,720. *Signaling Apparatus*, J. P. Tirrell, 313,784. *Apparatus for Operating Bells*, H. E. Waite and S. H. Bartlett, 313,788, 313,789. *Automatic Circuit Changer and Alarm*, W. B. Van Size and T. D. Lockwood, 313,841. *Bell*, C. E. Kells, Jr., 313,941, March 17.

Commutators:—*Automatic Cut-out*, J. Du Shane, 312,985, Feb. 24; J. B. May, 313,091, March 3; E. Gannaway, 313,318. *Contact Breaker*, G. S. Maxwell, 313,605, March 10.

Conductors, Insulators, Supports and Systems:—*Conductors*, W. R. Patterson, 10,563, re-issue, Feb. 24; C. M. Thompson and C. R. Eberle, 312,673; S. F. Shelbourne, 313,380, March 3. *System of Lighting by Secondary Batteries*, A. H. Bauer, 312,698, Feb. 24. *Cable Hanger*, W. R. Patterson, 312,755. *Electrical Conducting Material*, C. S. Bradley, 312,803. *Fire Engine System*, S. S. Wheeler, 312,939. *Circuit*, H. F. Campbell, 313,053, March 3. *Cable*, W. H. Eckert, J. A. Seely and E. A. Eckert, 313,305. *Hanger for Cables*, same, 313,410. *Clamp for Binding Wire to Insulators*, W. H. Sawyer, 313.377. *Clamp for Electrical Purposes*, W. S. Platt, 313,616, March 10. *Apparatus for Utilizing the Current Force of Flowing Waters in Producing Electric Currents*, A. Man, 313,746.

Dynamo Machines and Motors:—*Regulator for Motors*, F. J. Sprague, 313,247, March 3. *Regulator for Dynamos*, F. G. Waterhouse, 313,561, March 10. *Dynamo*, W. P. Freeman, 313,488; W. M. Mordey, 312,745, Feb. 24: A. Reckenzaun, 313,884, March 17. *Armature for*, C. E. Brush, 312,807, Feb. 24; W. Stanley, Jr., 313,894, March 17. *Commutator for*, W. P. Freeman, 313,489, March 10. *Motor*, F. J. Sprague, 313,546.

Galvanic Batteries:—*Amalgamating Zincs for*, W. S. Platt, 313,615, March 10. *Galvanic Therapeutic Apparatus*, T. Schmauserx, 312,660, Feb. 24.

Ignition:—*Shell Fuse*, E. L. Zalinski, 313,150, March 3. *Gas Lighter*, C. W. Weiss, 314,088, March 17; J. Geary, 314,119.

Lamps and Appurtenances:—*Support*, F. U. Adams, 312,789, Feb. 24. *Lamp Controlling Mechanism*, E. H. Amet, 312,944. *Vacuum Pump*, R. F. Barnes, 312,951. *Arc-Lamps*, M. N. Lynn, 313,006; C. O. Mailloux, 313,436, 313,437, March 3; W. P. Freeman, 313,487, March 10. *Lamp for Locomotives*, M. N. Lynn, 313,009, Feb. 24. *Focusing Arc-Lamp*, L. G. Woolley, 313,039. *Electric Jewelry*, A. Haid, 313,726, March 10. *Mouth and Throat Illuminator*, E. T. Starr, 313,782, 313,783. *Method of Protecting Incandescent Lamps*, N. S. White, 314,208, March 17. *Holder for Incandescent Lamps*, A. Swan, 313,965.

Metallurgy:—*Apparatus for Treating Metals by Electrolysis*, H. R. Cassell, 312,814, Feb. 24. *Apparatus for Electroplating*, D. Appleton, 313,569, March 10.

Miscellaneous:—*Surveying Instrument*, J. Hale, 313,494, March 10. *Fare Register*, C. A. Neuert, 313,513. *Apparatus for Controlling the Flow of Gases at a Distance*, F. L. Muratori and E. Cros, 314,188, March 17. *Indicator for Pool Tables*, 313,404, March 3. *Globe*, F. P. Montgomery, 313,752, March 10. *Electrotype Shell and Base*. G. W. and J. R. Cummings, 313,812. *Electro-Magnet*, E. D. McCracken, 314,041, March 17. *Safety Device for Elevators*, R. M. Curtiss, 314,167. *Automatic Steering Apparatus*, C. H. Washburn, 313,901.

Railways and Appliances:—*Signaling Apparatus*, W. Hadden, 312,627, Feb. 24. *Torpedo for Railway Signals*, S. F. Allen, 313,151, March 3. *Railway Alarm Mechanism*, W. M. Pease, 313,614, March 10.

Storage Batteries:—C. S. Bradley, 312,802, Feb. 24. *Electrolytic Fluid for*, W. E. Case, 313,058, March 3. *Apparatus for Charging and Discharging*, W. Stanley, 313,117.

Telegraphs:—*Combined Telegraph Relay and Telephone*, H. C. Strong, 312,670, Feb. 24. *Repeater for Submarine Cables*, M. Farmer, 312,831. *Municipal Telegraph*, J. C. Wilson, 313,147, March 3. *Printing Telegraph*, G. A. Cassagnes, 313,175, 313,176; H. Van Hoevenbergh, 313,786, March 10. *Multiplex*, C. G. Burke, 313,298, March 3. *Telegraphic Apparatus*, C. W. Williams, E. B. Ives and G. S. Barnum, 313,462. *Automatic Chemical Telegraph*, C. Westbrook, 313,791, March 10. *Automatic Telegraphy*, same, 313,792. *Means for Preventing False Signals Upon Reversals in Quadruplex*, H. Van Hoevenbergh, 313,787. *Chemical Quotation Telegraph*, T. A. Edison and P. Kenny, 314,115, March 17.

Telephone Systems and Apparatus:—*Telephone*, W. Hadden, 312,841, 312,842, Feb. 24. *Switch*, same, 312,843. *Battery Telephone*, T. D. Lockwood, 312,871. *Telephonic Apparatus*, C. A. Randall, 312,896. *Combined Telephone Receiver and Circuit Breaker*, W. H. Eckert, J. A. Seely and E. A. Eckert, 313,409, March 3. *Automatic Shunt for Telephone Lines*, 313,640, March 10. *Telephonic Connection*, 313,731. *Support for Transmitters*, H. B. Lytle and J. A. McCoy, 313,828. *Office Connection for Telephone Exchanges*, same, 313,829. *Telephone Receivers*, T. F. Taylor, 314,155, 314,156, 314,157.

Thermo-Electric Battery:—D. Lautensack, 313,215, March 3.

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NEW YORK, MAY, 1885.

ELECTRICAL PATENTS AND ELECTRICAL LITIGATION.

THE month of April, 1885, seems likely to become a somewhat memorable one in the annals of electrical patent litigation. It will be recollected that a few weeks since Judge Shipman, of the United States Circuit Court, denied the injunction which had been asked for by the Gold & Stock Telegraph Company to restrain the operations of its rival, the Commercial Telegram Company, on the ground of infringement upon the patent of E. A. Calahan, substantially for the reason that the patent was vague in its phraseology, so that its exact meaning could not be summarily determined.

The satisfaction with which this decision was received by the Commercial Telegram Company was, however, destined to be of short duration. The complainants succeeded in having the case brought almost immediately to final hearing, and as the defendants had neglected to take testimony within the time allotted, they were compelled to go to hearing without it, and to depend mainly upon the cross-examination of the complainants' witnesses to make out their defense. On April 1 Judge Shipman filed an opinion in favor of the complainant company, adjudging the Field printer employed by the defendants to be an infringement of the second claim of the Calahan patent, for two independent type-wheels printing in two lines upon one strip of paper. An injunction was subsequently issued against the Commercial company, to take effect on Saturday, April 11. Accordingly, on that day the Commercial company tied up one type-wheel on each of their instruments, some 300 in number, but continued to furnish quotations by printing with the alphabetical type-wheel only. They succeeded in getting through with the work more rapidly than might have been expected, although the peculiar abbreviations used, such as "ath" for eighth, "aty" for eighty, however familiar they may have been to the old school of printing telegraph operators, must have been like so much Greek to many of the brokers. In fact, if it had been Hebrew it would probably have been far more intelligible, at least to some of them.

The situation was further complicated by the fact that the Calahan patent expired by limitation on April 21. The day before the injunction went into effect, Mr. Buckingham, the counsel of the Gold & Stock company, addressed a circular to the subscribers of the Commercial company, notifying them that printing even with one type-wheel constituted an infringement, that suits would be instituted against the individual users, and that the injunction would not permit the use, after the expiration of the patent, of infringing instruments which had been made during its lifetime. The Commercial company the next day issued a counter proclamation, containing an opinion signed by their counsel, Roscoe Conkling and Samuel A. Duncan, to the effect that printing with one wheel did not constitute an infringement. It also commenced an action in the Superior Court against the Gold & Stock company, claiming $50,000 damages for an alleged libel contained in Mr. Buckingham's circular.

Thus matters rested until the day after the expiration of the Calahan patent, when the Commercial company proceeded to operate both wheels of their instruments in the usual manner, regardless of a second proclamation which had in the meantime been sent out by Mr. Buckingham, that the injunction would be still of full force and effect after the expiration of the patent, in respect to the use of instruments constructed in violation of the patent. So far as we can judge from the tenor of previous decisions involving the same point, the Gold & Stock company appear to have the law on their side. Precisely what will be the outcome of this apparent defiance of the injunction of the United States Court cannot yet be predicted. The action has undoubtedly been taken under the advice of eminent counsel, and the result will be awaited with interest.

A decision was rendered by the Supreme Court of the United States on April 6, in the case of the Electric Railway Signal Company against the Hall Railway Signal Company, which, although not one of especial importance, is interesting as having been the first electrical case before the Supreme Court since the celebrated telegraph suit of O'Reilly v. Morse, in 1852. It was commenced in Connecticut in 1875, and decided by Judge Shipman in the Circuit Court in favor of the defendants, on the ground that their assignee was in law the first inventor, a decision which, in view of the proved facts in the case, was regarded with great surprise in legal circles. Upon appeal the Supreme Court also decided for the defendants, but this time on the ground that their apparatus did not infringe the complainant's patent. The invention involved in the suit, although in very extensive practical use at one time, is now obsolete, having been superseded by improved systems.

The Supreme Court also decided on April 20 a case of considerable interest, involving the polishing and hard finishing of insulated electric wires, an invention which has practically become a very important one, on account of the enormous growth of the electric wire industry within the

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past few years. The original suit was brought in Connecticut by the Western Electric Manufacturing Company of Chicago, against the Ansonia Brass and Copper Company, for infringement of two patents, one for the process of waxing, compressing and polishing the braided coating of the wire, and the other for the manufactured article thus produced. Judge Shipman, of the Circuit Court, held that inasmuch as the same process had before been applied to wires coated with cloth and saturated with bitumen or fatty substance, that no invention was required to apply this old process to a new use. The Supreme Court now affirms this decision, and thus this important process is thrown open to the public. It is certainly to be regretted that the inventor of so important an improvement, from a practical point of view, should not have been adequately rewarded. Any one accustomed to handling the rough, greasy and unhandsome wires which were in universal use before the introduction of this improvement, cannot feel otherwise than grateful to the person to whom they are indebted for the introduction of the elegant and highly finished products of to-day.

A reference to the list published in another column will show that besides the Calahan printing telegraph patent, a number of other patents of considerable celebrity have expired within a few days, among others the celebrated Page patent, the great electric bug-a-boo of the past 15 years, which has been so often employed by the Western Union Telegraph Company to threaten and annoy its rivals. No serious attempt was ever made to enforce it, so far as relates to telegraphic apparatus, although a suit brought against the Holmes Burglar Alarm Telegraph Company resulted in the claims of the patent being sustained, so far as its application to that apparatus was concerned. Many important patents affecting electrical interests will expire within the next few years, whereby the field open to inventors will be perceptibly broadened, and they will be better enabled to work out their ideas without laying themselves under tribute to their half-forgotten predecessors.

THE PERIODICAL REVOLUTION IN TELEGRAPHY.

While state legislatures and the public press, are actively engaged in ostensible efforts to protect the people from the encroachments of monopolies, comparatively little attention is paid to the suppression of various schemes for swindling would-be investors, based upon alleged marvelous inventions. As we have often heretofore had occasion to point out, electricity affords a peculiarly promising field for the exploitation of questionable enterprises of this character, and as the general public apparently do not consider it worth their while to keep informed upon the actual progress of invention, unscrupulous adventurers take advantage of this state of affairs, to form companies, sell stock, and secure the spoils before the visionary character of their projects is exposed.

A recent example under the old, old title of a "Revolution in Telegraphy" has recently been brought out in a neighboring city. It is stated that the instrument to be used is provided with a key-board like a type-writer, and as the letters are plainly marked on their respective keys, it is obvious that no skill is required in the transmission of messages. Indeed it is reported that at an exhibition trial a non-expert easily printed at the rate of forty or fifty words a minute That this statement is false, is obvious to any person familiar with key-board manipulation. Those who imagine that the selection of letters is the only qualification required for a transmitting operator, evince their entire ignorance of the business. By the same process of reasoning, it might with equal truth be asserted that a compositor would require no training, if the boxes in a type-case were lettered, or that any ordinary person might become an expert pianist, immediately upon becoming familiar with the reading of music, provided the keys of the instrument were properly identified.

Another remarkable feature of this wonderful instrument upon which much stress is laid, is that it prints a duplicate copy at the sending station so that the operator may at once detect any error which he may have made. As this can be done by the printing instruments now in use without the least alteration, but is dispensed with in commercial telegraphy because it is of no practical utility, this alleged improvement is not worthy of mention. The same argument applies to the secrecy of the system, as it is practically impossible to read by sound from any printer, although there may perhaps be found an occasional expert who can read from the vibrations of a step-by-step instrument using a single type-wheel. The idea that any system of this character will, as is asserted, supersede both the Morse telegraph and the telephone, is evidently based upon pure ignorance or worse, as the improvements to which special attention is called, are either such as already exist, possibly in other forms, or they are wholly unnecessary in actual practice. It is claimed that the effect of the introduction of this new system, will be the opening of some 40,000 new telegraph stations in railroad and express offices throughout the United States where none now exist. There is no particular reason why these stations may not now be opened if necessary, using the ordinary Morse register, which any person of average intelligence can learn to operate in one-quarter the time that they can a key-board printer. So long as a new crop of adventurers matures every few years, such schemes will continue to be published broadcast, with the hope of securing a fresh grist of victims; but it is to be regretted that their misleading prospectuses are allowed to appear in the guise of legitimate news in the columns of respectable journals whose business is supposed to be to protect the public from such questionable projects, rather than to assist in their consummation.

TELEPHONES FOR THE MILLION.

OUR rural friends are suffering from a lack of telephones, or at least they think they are, in every household. They would like to have them furnished gratuitously, but as no practical plan has yet been proposed by which this desideratum can be attained, they petition the state legislature for a reduction in rates. The comparatively unimportant fact that they are paying about two dollars more per ton for coal than they ought, is apparently not worthy of serious attention. If coal gets too high, they manage to get along without it, but telephones are a necessity of human existence which they must be permitted to enjoy at a reasonable price. Considerable curiosity has been aroused as to what might be esteemed the proper

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figure for telephone rental by these helpless victims of a grinding monopoly. Recent action on the part of the collective wisdom of the Indiana legislature has placed the limit at three dollars per month, or about ten cents each day. We have yet to learn whether the telephone companies have expressed their willingness to comply with the rate thus arbitrarily established, or if any provision has been made by the legislature compelling the companies to continue the business of leasing telephones to the Hoosiers at unremunerative rates. The rate for telephones in New York city is $150 per year, yet we have heard nothing as yet of any petitions to the legislature to reduce the rentals. On the other hand, the state is actually forcing existing companies to expend large amounts for subterranean construction, which will render the maintenance and possibly the increase of existing rates an inevitable necessity. No fair-minded person can reasonably object to the earning of moderate profits by local telephone companies, otherwise there would be no incentive to the establishment of exchanges. That they have already found a field in towns which would barely maintain a country newspaper, proves that the general rate is not too high, otherwise a sufficient number of subscribers would not have been obtained, to support them.

A much more sensible proceeding would be for the legislature to compel livery-stable keepers to rent their horses and carriages at ten cents a day. Everybody has almost daily use for a horse and carriage, but they cannot begin to afford to pay the extortionate prices charged by the livery-men, and so they are compelled to trudge wearily on foot, while it is well known that no person who values his peace and comfort would have a telephone in his house at any price,—unless he is a member of the Indiana legislature.

A FLOURISHING INSTITUTION.

The American Institute of Electrical Engineers will hold their annual meeting for the reading of papers and election of officers for the ensuing year in this city on the 19th of the present month. It is to be hoped that there will be a full attendance of members of the Institute and others, as a number of papers of unusual interest and value have been promised for this meeting. The Institute has recently issued its first volume of transactions, a more particular reference to which will be found in another column. The exceptionally high character of some, and in fact most, of the papers read at Philadelphia, gives us reason to look forward to an occasion of unusual interest. The success of the Institute during the first year of its existence has been unusually gratifying, especially to those who, not without the expenditure of considerable time and labor, effected the preliminary organization and started the society in its career. The present membership comprises many of the ablest electricians and electrical engineers in the United States, and it represents almost every department of industry in which electricity finds a place. Dr. Norvin Green, president of the Western Union Telegraph Company, has held the office of president during the year, and the Institute has reason to feel greatly indebted to him for the careful personal attention he has given to its concerns, and the active interest in its welfare which he has exhibited during his term of office. It goes without saying that the unanimous voice of the members will be in favor of his re-election.

We learn that the society is in excellent financial condition, and it appears to have established itself on a permanent basis. By the courtesy of the American Institute of Civil Engineers, the council meetings during the past year have been held at their rooms. It is understood, however, that a movement is on foot among the different scientific and other similar societies in New York city to secure a permanent fire-proof building for the reception of their valuable libraries, collections and other properties. These are collectively of enormous value, and their loss by fire would be absolutely irreparable. It is proposed that each society have its own special rooms, while a general auditorium for annual meetings and the like will be provided, the use of which will be common to all. We believe that the time is ripe for this undertaking, and we see no serious difficulty in the way of its being carried out successfully at an early day. It is probable that capitalists may easily be found who will undertake to erect a suitable building in a central location, provided all the societies, or a sufficient number of them, would unite and take permanent leases of their apartments.

The Institute of Electrical Engineers is, as we are pleased to learn, lending its active co-operation to this project, in which effort we wish it every success.

DARKNESS PREFERRED TO LIGHT.

At a meeting of the New York Board of Aldermen April 24th, an estimate of the comparative cost of street lighting by gas and electricity, was submitted by S. Mc Cormick, Superintendent of lamps and gas. He stated that the resolutions of the Common Council called for 2,003 additional arc lamps, to replace 5,345 gas lamps. This statement conveys a very erroneous impression as to the efficiency of the electric lights. The records prove that they have heretofore replaced from 8 to 12 gas lamps each, according to location. The Superintendent even goes so far as to say : "I have not discovered any advantage which the electric light possesses that cannot be obtained from gas lamps, except the instantaneous lighting."

No claim in behalf of the advantages of electric street lighting, has been more generally admitted than that of the additional security it offers to life and property. No portion of the community have been more earnest in their endorsement of its practical value, than the police authorities of the different cities where electricity has been introduced. The very fact that one single petition in favor of electric lighting represented $400,000,000 capital would seem to be sufficient evidence that the city taxpayers are willing to assume the additional burden, although the extra cost is trivial.

New York is the metropolis of America and requires the most perfect system of street illumination, at any reasonable cost. Not only the principal streets, but every lane and alley ; places where daylight scarcely penetrates, should all be thoroughly illuminated. If there is any job lurking in the suspicious statement of Superintendent McCormick perhaps a beam of light turned in that direction, may unearth some interesting developments.

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ARTICLES.

THE NATIONAL SELF-BINDING INSULATOR.

THIS insulator, which is now being placed upon the market, embodies certain new features which appear to be of greater practical value than any improvement made in glass insulators since the introduction of the internal screw-thread, now almost universally used in this country. This improvement enables the ordinary tie-wire to be wholly dispensed with, the insulator, with its clip, being so formed that the line-wire is readily placed in position, and rigidly secured without the aid of tools. The insulator can be applied in any position, wherever the ordinary pattern is available.

Upon the exterior of the upper portion is formed a conical and gradually expanding screw-thread, similar in shape and principle to the point of a gimlet. By the use of a rigid wire shackle or clip the line-wire is attached as shown in figure 1. The clips are prepared ready for use as shown in figure 2, the main curve being so formed as to encircle the body of the insulator at the base of the conical screw, while each end is bent into a hook, which grasps the line-wire as shown. The bell of the insulator below the resting place of the line-wire is of a form which experience has shown to be the most desirable for insulating purposes. In attaching the line-wire, the insulator is first screwed a short distance upon the pin, and the point of the screw-top inserted within the clip, which has been previously hooked over the wire at the proper point, as shown in figure 2. The outside and inside threads being led in opposite directions, two or three turns of the insulator brings it to its bearing on the pin, at the same time carrying the clip with the wire into its proper position, as shown in figure 3. A little practice enables the lineman to do this work with the greatest ease and rapidity, while the attachment is perfect in appearance and security. This ingenious and effective device is the invention of J. Slater Lewis, of Birkenhead, England. It has been used in Europe and India for some time, where it has been highly approved, and pronounced to be the only insulator thoroughly adapted to the various requirements of telegraph construction. The principal English railways and telephone companies are now using it, and after rigid tests the officers of the British post-office telegraph have decided to adopt it exclusively for all future work. It may be mentioned that the internal screw of this insulator is more perfect than any heretofore made, by reason of the use of newly-invented molding tools (patented by L. B. Gray and J. Ham, October 7, 1884), which give greater sharpness and accuracy to the thread. Thus the insulator is not only held more securely to the pin, but is more readily attached, while the loss arising from the discarding of insulators which are defective in this respect is avoided. Various advantages of more or less importance are secured by the use of this insulator. A considerable saving in new construction may be effected, as after a little experience a considerably greater length of wire may be strung in a given time by the same number of hands than by the old method. In renewing line-wire on poles its superiority is still more apparent. In replacing broken insulators, changing poles, etc., no tools of any description are required in order to transfer the wires. The discarded insulator can be unscrewed or broken to pieces in an instant, and the new one substituted without disturbing the clip or even ordinary tie-wire, if the latter be used. Where a line has been constructed with this insulator no expense for new tie-wires will be incurred in re-building, nor time consumed in removing the old ones. The same clips may be used and removed repeatedly without damage.

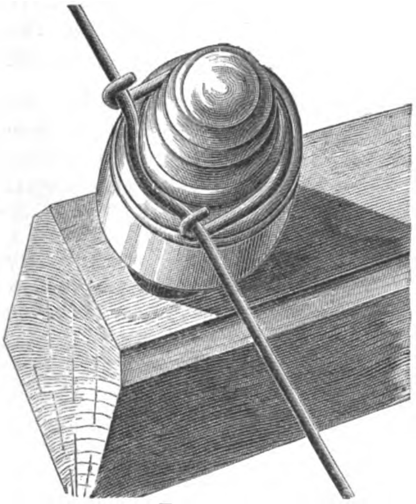

FIGURE 1.

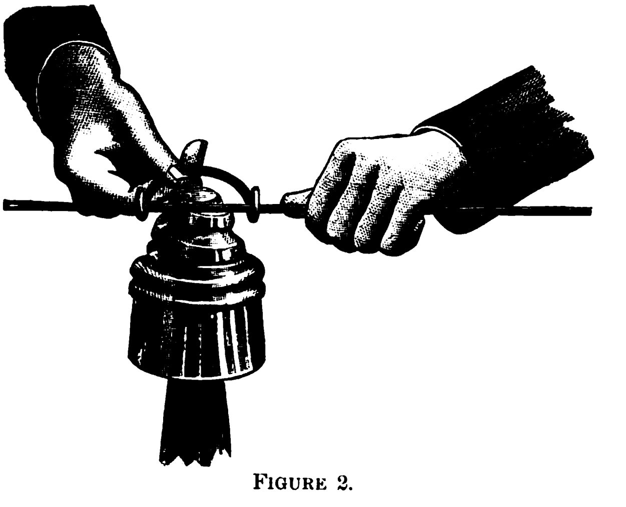

FIGURE 2.

FIGURE 3.

One of the most important points to be gained by its use is the greater durability of the line-wire, which is due to the fact that as no tools are used in making the attachment, the zinc coating of the wire is not abraded. Mechanical injuries of this nature permit the access of moisture; the iron or steel is attacked by rust, resulting in weakness and ultimate breakage. Better insulation is also secured, as there are fewer crevices to facilitate the accumulation of soot and dust, while those which do exist are open to the cleansing action of rain. By proper adaptation of the length of the clip, the wire may be held at any required degree of tightness.

The old tie-wire fastening may be used in connection with this insulator, as with the ordinary pattern. Used in this manner, it is equal in every respect to the old form, retaining, however, the important advantage of replacement, with less than half the time and labor. In order to meet every possible requirement in either building or rebuilding, these insulators are now being made in the same standard sizes as have been generally used heretofore.

HARD-DRAWN COPPER WIRE AS AN OVERHEAD CONDUCTOR.

BY WM. MAVER, JR.

IT has, of course, long been known that copper possesses electrical qualities far superior to iron as an overhead conductor for telegraphic and telephonic purposes, but these

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superior qualities have not been availed of to anything like the extent they would have been had the intrinsic value of copper not been so high, its tensile strength so low, and its tendency to elongate, or "draw out" so great, in comparison with iron; three very serious and, in fact, fatal objections to its successful employment in the capacity of an overhead electrical conductor.

But the almost simultaneous demand for a better electrical conductor than iron for telephonic purposes together with the surprising fall in the price of copper, which has recently occurred, has led to the making of a great many experiments with this metal, with a view to utilizing it for the above purposes. These experiments have resulted in the production of what is now known as hard-drawn copper wire, which, it is more than likely, will prove—indeed has already proven to be—an excellent substitute for iron as an overhead conductor.

The opinion hitherto held by many with regard to the employment of copper for this purpose has been that owing to its low tensile strength and softness, it would not withstand the changeable climate of this country. This opinion was doubtless founded chiefly on the experience of Morse with his first wire between Washington and New York, which was of copper, and, as is well known, was a complete failure. In referring to this failure, Mr. James D. Reid, a contemporary of Morse, in his popular work "The Telegraph in America," cites the fact that an intelligent mechanic of New York, named B. Tucker, proposed to improve the tensile strength of the copper wire by running two strands of the metal through a die, thus drawing it "hard;" and Mr. Reid states that several miles of copper wire were thus drawn and erected on the poles, but as iron wire was then satisfactorily filling the place of copper between the above points, Mr. Tucker was not encouraged to proceed, and copper wire as an overhead telegraph conductor fell into complete disuse.

This, however, so far as I have been able to ascertain, was the first attempt to produce hard-drawn copper wire. The term "hard-drawn" has been given to copper simply as a distinguishing name. With equal propriety the iron wire commonly used for telegraphic purposes might be termed hard-drawn iron wire, for the process by which the different metals are drawn is almost precisely the same in each case; that is, they are first made into iron or copper rods and are then drawn through one die after another until the desired diameter is reached. In each case the different metals are annealed during the process of the drawing, although in the case of iron the annealing is much more frequent, and after its last drawing it is again annealed; while copper, after the last drawing, is not annealed. The cause for this is, that unannealed iron would be so hard and stiff that it would be a difficult wire to handle. The annealing process renders it softer and more pliable, and this without detracting too much from its tensile strength, in fact it adds thereto. Were copper wire similarly annealed after the last drawing it would be much too soft for service as an overhead telegraph wire. That this is the case will readily be seen when it is stated that No. 12 B. W. G. copper wire annealed has a tensile strength of only 330 pounds, while it will elongate 36 per cent. of its length. On the contrary, unannealed copper wire, namely, that which is known as hard-drawn of the same size, has a tensile strength of about 575 pounds and will not elongate more than one per cent. without breaking.

It has for a long time been supposed that an overhead conductor, to be entirely successful, must have a high tensile strength coupled with an elongating quality of at least 18 per cent. There has never been any difficulty in producing an iron wire with these qualifications, but in the past and present state of the art it is impossible to combine in copper these two requisites.

With copper we may obtain a low tensile strength and great elongation—or high tensile strength and little elongation, but not otherwise. The question has, however, arisen within the past year or two, as to what constitutes the necessity for so high a percentage of elongation in telegraph wire; and to this question no one appears to be able to furnish a very satisfactory reply.

I am aware of one prominent electrician who recommended that iron having a very high percentage of elongation and great tensile strength should be used in localities where sleet storms are frequent, in order, as he said, that the weight of the sleet should sag the wire until it touched the ground, which would thus prevent the wire from breaking; while the ice would sufficiently insulate the wire to allow of the transmission of signals almost as usual.

After the ice had melted, the wire was expected to return to its former elevation. The same gentleman stated that this plan was in vogue in the Highlands of Scotland.

Of course if a wire is to be expected to repeat the above performance on the occasion of every sleet storm, the necessity for a high percentage of elongation, and elasticity also, would be obvious, but, even granting that such an arrangement is practicable where there is but one wire on a pole, it would be quite useless where many wires are strung on one pole, as the wind would quickly cross them.

As a matter of fact, however, it is difficult to find any valid reason for requiring an elongation exceeding, say, from one to two per cent; for, in case of a weight of sleet on the wires it becomes at once a question of tensile strength.

If the weight of sleet exceeds the breaking strain of the wire it will break, whether the elongation of the wire be one or 30 per cent., always providing that the wire does not stretch until it reaches the earth, as above referred to.

Perhaps the principal reason hitherto offered for the necessity for great elongation in a telegraph wire has been that such a quality is requisite in order that the wire may withstand the contraction of the metal due to a sudden lowering of temperature; but a little calculation will show that even to meet this requirement a percentage of elongation of from one to two will amply suffice.

For instance, according to Trautwine, copper will expand or contract one part in 100.4 parts for every degree of rise or fall in the temperature. This would give, in the event of a sudden fall of, say, 130° Fahrenheit, a contraction of about 130 feet in 19 miles of wire. That is about 7 feet per mile—or, supposing 30 poles per mile, a contraction of 23 hundredths of a foot between poles. One per cent. of elongation would amount to 52.80 feet per mile, or about 1.7 feet between poles.

It should be noted here that the percentages of elongation of hard-drawn copper wire, given above, have been obtained by measuring the elongation after the wire has actually broken and hence the elongation at the point of fracture was also measured. Careful calculations, however, showed that the wire, exclusive of the fracture, elongates about .75 per cent.

Thus, without including the slack, more or less of which is always to be found between poles, the above percentage of elongation would more than meet any strain that is likely to arise from contraction due to sudden changes in the temperature.

This being true it becomes necessary to find a theory which will account for the fact that in almost every case on all newly constructed wires there are numerous breaks caused by the first sudden fall of temperature. Close observation has shown that on the average from six to ten breaks occur at such times in about every 100 miles of iron or hard copper wire. The average has been slightly less thus far in the case of copper. After the first severe frost the wires seldom break from this cause and they are then said to be seasoned.

It is a fact that in almost every instance the breaks in iron wire due to changes of temperature, occur at flaws in the metal. The theory then is, either that moisture enters these flaws and freezing therein thus breaks the wire; or, that the flaws, which generally consist of brittle or partly

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honeycombed portions of wire, having no elongation whatever, break under the additional strain due to contraction.

In the case of hard-drawn copper wire the breaks that occur after a sudden fall of temperature have in almost every instance been found at bad joints or kinks. Inasmuch, therefore, as neither iron nor copper continue to break after the flaws and kinks have been disclosed by the first severe frost it would seem that the above theories are correct. These results show very clearly the necessity for the exercise of great care in the inspection and construction of telegraph lines.

Many experiments have been made with the view of obtaining a copper wire having a combination of high tensile strength and a moderately high percentage of elongation, but so far the results have not been encouraging.

It has been uniformly found in all these tests that as the tensile strength rises the elongation rapidly decreases, and this occurs whether the wire is brought to the desired diameter or size with two or three drawings, or with eight or ten drawings.

For instance in one test, of which I have a record, eight pieces of wire were experimented with, and it was found that to obtain an elongation of from 2.5 to 3 per cent. in a No. 12 hard-drawn copper wire it was necessary to reduce the tensile strength from 130 to 140 pounds.

Starting with a No. 10 (diameter 135 mils.) annealed wire and drawing it twice to reduce it to a diameter of 104 mils (about No. 13, B. W. G.) the wire showed an elongation of 23 per cent. and a tensile strength of 330 pounds, while the same wire, drawn three times to reduce it to the same gauge, viz: 104 mils, had a breaking strain of 410 to 420 pounds, and elongated but 3 per cent.

These results seemed to indicate that there is no regular ratio of increase or decrease of tensile strength with the number of drawings to which the wire may be subjected in the course of reduction to a certain size. Nor is an increase in the percentage of elongation always accompanied by a corresponding increase in the ductility of the wire, or by a fall in the tensile strength; thus a wire of 104 mils diameter has been manufactured in which the tensile strength has risen to 600 pounds, and this with a percentage of elongation of from 2 to 2½ per cent., while in the same wire there was a marked falling off in ductility.

This difficulty in combining the foregoing qualities in copper wire has, of course, led to many efforts to secure an alloy of copper and some other cheap metal, which would impart to the copper a much greater tensile strength, without at the same time detracting too much from its electrical conductivity, but up to the present time without success.

This is doubtless chiefly due to the great falling off in conductivity which is manifest in alloyed copper. For instance, calling the conductivity of pure copper 93.08 at 18° C. Messrs. Matthiesen and Holzman have recently ascertained by careful examination that the conductivity of copper alloyed with but 0.48 per cent of iron is reduced to 34.56 at a temperature of 11.2° C., while the conductivity of copper alloyed with 2.45 per cent of silver, itself a better conductor than copper, is reduced to 79.38 at a temperature of 19.7° C.

As I have already intimated, however, there does not appear to be any good reason why an overhead telegraph wire should be required to have a high percentage of elongation, and I am sustained in this view by several experienced superintendents of construction of telegraph lines. It is their opinion that a wire possessing from 1 to 2 per cent. of elongation and fairly ductile, with a tensile strength of at least 2½ times its own weight per mile, will meet all the requirements, and these views are strongly borne out by the excellent manner in which the thousands of miles of hard-drawn copper wire on the poles of the Baltimore and Ohio Telegraph Co., and many local telephone companies, have withstood the extreme changes in temperature of the past severe winter. The superintendent of a Michigan telephone company writes: "my experience with our 90 miles of No. 12 copper wire has been remarkable, notwithstanding the extreme variations of temperature we have only had one break this winter."

Of course these gratifying results have not been obtained without much care in the construction of the lines, but the results obtained have well repaid the care bestowed in this respect.

In stringing hard-drawn copper wire on the poles, the method employed by the Baltimore and Ohio Telegraph Co. has been to draw the wire up quite tight, leaving no perceptible sag between the poles, which has been found advantageous in several ways, for example it lessens the liability of the wires to swing together, and also, by limiting the sway, to-and-fro, of the wire, decreases the liability of chafing at the insulators. In addition to this it has been found by observation that the less the sag of the wire the less is the danger of the wire breaking from a weight of ice during a sleet storm, inasmuch as the rain is much more apt to drop off the wire, or be blown off, the nearer the wire attains a perfectly horizontal position between the poles. It has frequently been noticed that on badly sagged wires the sleet is much the thickest midway between the poles, doubtless due to the rain following the course of the sag and freezing as it flows.

In connection with this subject the following specifications of the Baltimore and Ohio Telegraph Co. for hard-drawn copper wire weighing 170 pounds per mile, about equal to No. 13, B. W. G., will probably prove interesting.

SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE WEIGHING 170 LBS. PER MILE.

Resistance per mile	5.23 ohms at 60° F.
Weight per mile ohm	889.1 lbs.
Diameter in mils	.104
Conductivity at 60° F.	98% of pure copper
Elongation	1.25% to 1.50%
Tensile strength	550 lbs.
Twists in 6 inches	40
Bends upon itself	3½

All wire furnished to be smooth, bright and polished, round in cross-section, and without kinks or indentations of any kind.

Length of coil at least three-quarter mile without splice.

Minimum weight of bundle without packing 127½ lbs.

Weight of each bundle to be marked on accompanying tag.

After having been passed by the company's inspector, each bundle to be tied with four bands, then thoroughly covered with burlaps or sacking, and wound with 15 turns wire outside.

A few words explanatory of some of the above technical terms may not be amiss here.

By weight per mile ohm is meant the weight of one mile of wire of a certain percentage of electrical conductivity which would be required, to obtain a resistance of 1 ohm.

The weight per mile ohm is thus the product of the weight per mile and the resistance per mile; that is in the above case 170 lbs.×5.23 ohms.=889.1 lbs.

The conductivity of pure copper is generally placed at 100 and the best authorities calculate the weight per mile ohm of pure copper to be 871.177.

Thus a pure copper wire weighing 170 lbs. per mile should have a resistance of 5.12 ohms per mile.

The wire is tested for ductility by bending upon itself. For instance, pieces of the wire about 10 inches long are bent and straightened to their original positions (in the same manner, for example, as a pocket knife is opened and closed) until they break. One bending and straightening of the wire constitutes one bend on itself.

In addition to the above specifications it is required that each coil shall be rewound on a drum in the opposite direction to that in which the wire is wound during the final drawing; the object of which is to take the "spring" out of the wire. It is also customary during the operation of this last winding to cause the wire to pass through a piece

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of burlaps, held in the hand of an employé, to detect any rough or splintered portions of wire. This last winding is quite an important matter as it greatly facilitates the handling of the wire during construction, and, of course, also lessens the tendency of the wire to "curl" around adjacent wires when it happens to break.

As previously stated, there does not appear to be any regular ratio of increase of tensile strength and decrease of ductility of copper wire, consequently a wire which will meet the above specifications as to tensile strength, ductility and elongation can only be obtained by actual experiments. Thus, starting from a copper rod $\frac{7}{32}$ of an inch in diameter, it has been found that to produce a wire $\frac{104}{1000}$ of an inch diameter having the desired qualities, it is necessary to give it from 12 to 14 drawings and to anneal it about four times between the drawings.

Until quite recently difficulty has been experienced in furnishing hard-drawn copper wire of any considerable length, in a continuous coil and without joints. This was owing chiefly to the difficulty in maintaining the gauge of the die a uniform size—but by means of what is known as the Cowles silver solder joint, lately patented, unjointed coils of any length are now obtainable.

This joint is made by tapering the ends of the wires to be joined, and silver soldering them. The joint is then passed through the die, after which it is scarcely discernible. Tests made of these joints for tensile strength show only a very slight falling off as compared with unjointed wire.

Careful electrical tests show that the conductivity of hard-drawn copper wire is 2 per cent less than annealed copper. Thorough chemical tests of the wire now furnished by the various manufacturers prove that it is about 99.999 per cent. of pure copper, there being only the slightest trace of impurities.

That this is true is evident from what I have previously said as to the effect of alloys on the electrical qualities of this metal.

So far as I can learn there are now in successful operation about 10,000 miles of this wire in the United States, of which from 7,000 to 8,000 miles are on the lines of the Baltimore and Ohio Telegraph Co. The remainder is on the lines of various local telephone companies, and in view of the uniform success attending its use by all of these companies, and the acknowledged superior electrical qualities of copper over iron, there can be little doubt but that hard-drawn copper wire is destined to be the principal overhead electrical conductor of the future.

TAYLOR'S ELECTRIC TELEPHONE.[1]

BY THEODORE F. TAYLOR.

In the present paper I propose to tell what I know of the telephone.

Having made alleged improvements in the art, and having been so fortunate [or otherwise] as to have obtained from this and several foreign governments letters patent for the same, it is natural that I should take pride in explaining my invention to my electrical friends.

Before going any further, however, I wish to make an announcement which may startle you all and relieve the minds of some. I do not claim to be the original inventor of the telephone. While half the states of the Union claim that honor for one of their sons, my native state of Delaware makes no such claim. I am only a gleaner in a field already harvested.

My first effort in the line of telephonic invention was made several years ago, when it occurred to me that a receiver might be constructed on the principle of the attraction and repulsion of currents. In the text-books the attraction and repulsion of currents is treated under the head of electro-dynamics,—that is: the laws of electricity in a state of motion, or the action of electric currents upon each other and upon magnets, while electrostatics deals with the laws of electricity in a state of rest.

The action of an electrical current upon another was first investigated by Ampère, shortly after Oersted's celebrated fundamental experiment. All the phenomena, even the most complicated, follow from two simple laws, which are:—

1. Two currents which are parallel, and in the same direction, attract one another.

2. Two currents parallel, but in contrary direction, repel one another.

After some study upon this theory I made my first model, and tried it in connection with an ordinary Blake transmitter.

The model consisted of two confronting flat coils of fine copper wire, cemented to two hard rubber discs, and held in a wooden case. Not obtaining satisfactory results with an induced current, I laid this model aside.

My next connection with the subject was when I was requested as an expert to investigate the researches of Philipp Reis,—to construct and operate the instruments described by him. I will here remark that at the time I began this investigation I was but slightly acquainted with the history of the telephone and the claims of rival inventors; but such knowledge as I had led me to suppose that the inventions and publications of Reis had but little relation to the invention of the modern telephone.

I constructed all the forms of transmitters and receivers described by Reis and succeeded in making them all transmit and receive articulate speech. The lectures and papers of Reis prove him to be the original inventor of the telephone. He was not only the inventor,—he fully understood the principles of their operation and construction, and he imparted his knowledge to others in the plainest language. He invented a name for his instruments. He called them "The Telephone." My feelings are strong on this subject, because I am not only indebted to Reis for instruction in the art, but it was one of his transmitters that first made my receiver talk. It has been the fashion to belittle the inventions of Reis for the reason that they failed to become of any commercial value under his hands. He was looking for scientific and not financial success.

I have never heard the great discoveries of Newton belittled for the reason that he failed to apply for a patent on gravitation.

My experience with Reis's instruments made me familiar with battery transmitters, and on connecting one up with my old model I heard it talk and was encouraged to develop it. In explaining my invention I cannot do better than quote from my application for a patent:—

"My invention is based on the well-known fact that electric currents when they are caused to traverse neighboring parallel conductors in the same direction, exert upon each other an attractive force, and when in opposite directions a repulsive force; and the degree with which they so attract or repel, is dependent upon the proximity of the conductors and the strengths of the currents. When, therefore, the positions of the conductors are approximately constant the variations in force may be considered as depending upon the variations in strength.

"Parallel results are obtained when an electric current is caused to pass through a single electric conductor in proximity to a continuation of itself.

"Upon this principle the invention is essentially based, and it consists generally, in so disposing an electric conductor that different portions of its length are brought into proximity to each other and a current of electricity caused to traverse the same will pass and repass in approximately parallel directions or in opposite directions through such different portions."

Without further explaining the principles upon which my receiver is supposed to work, I will describe in a few words some of my early experiments.

1. Read before the New York Electrical Society, April 22, 1885.

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My first model consisted of two flat coils of fine wire cemented to hard rubber discs. To demonstrate the principle I then procured an old violin (which I have here), and stretched two fine steel music wires (of No. 26 gauge) over the bridge, and made the connections so the current traversed the wires in the same direction. Upon using a quantity current I found this instrument reproduced speech, although faintly. I then cemented a flat coil to an ordinary butter dish about two inches in diameter, also to glass and mica plates. Another form was made by cementing wire inside a thin glass tumbler. All these forms of receiver gave results more or less satisfactory.

When a mass of iron was brought near any of these receivers, the sound was reinforced.

When one of the coils was placed upon an ordinary flat-iron the volume of sound was more than doubled.

A coil was cemented to an iron disc, and the result was encouraging.

Then two coils were cemented to iron discs which were fastened in a wooden case. This made an excellent receiver. The attraction between these coils is quite strong. Here is an illustrative model in which one coil is fixed and the other free to move. On connecting the battery you see one coil move towards the other. With this form of receiver the reproduced speech was clear and faultless. The consonants were properly reproduced. Such words as sunset, fructify, pencil, etc., were faithfully rendered. One form of receiver was made of iron wire made into flat coils, and responded to induced currents. Another form was made of both iron and copper wires laid parallel and made into a flat coil. This was not very good.

I sought to increase the volume of sound by using large discs, but the voice sounded muffled and indistinct. My best form of receiver is now made as follows :—

Within a suitable case are supported two plates or discs 2¾ inches in diameter, which may be of metal similar to the diaphragms usually employed in the well-known form of telephones, or they may be constructed of paper, vulcanized fibre, glass, mica, wood, porcelain, or other suitable resonant material. One of the plates is perforated at its centre. The plates are separated by a thin ring of hard rubber. Upon the confronting surfaces of the two plates are placed two flat coils of No. 36 copper wire, fastened by shellac varnish, and they are connected with each other in such a way that a current of electricity entering one terminal will pass through the coils in succession, and through the convolutions of the same in parallel directions. While a steady current is flowing the two coils and plates will be attracted towards each other, by reason of the attractive force exerted by the two broad streams flowing in the same direction.

In figure 1, A represents a case of hard rubber for supporting the several parts of the instrument. This case is made in the form of a wide ring in two sections, *a*1 and *a*2, adapted to be screwed together as shown. Within the case A are supported two plates, *c*1 and *c*2. One of the plates is perforated at its centre, as shown at *f*1, and they are separated a slight distance from each other by means of an intervening ring of hard rubber, *a*3. Upon the confronting surfaces of the two diaphragms are cemented two flat coils of wire, as shown at *c*1 and *c*2 respectively.

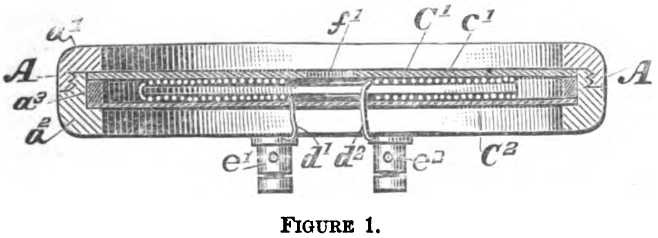

FIGURE 1.

In figures 2 and 3, two different methods of connecting the spiral coils are illustrated. According to the plan illustrated in figure 2, the current is caused to traverse both conductors in parallel directions and the two spiral coils will be attracted towards each other by reason of the attractive force exerted by the current upon itself in the several portions of the conductor.

In figure 3, an organization is illustrated in which the connections of the two coils are so charged that the current is caused to traverse the same in opposite directions and the two coils are repelled by each other.

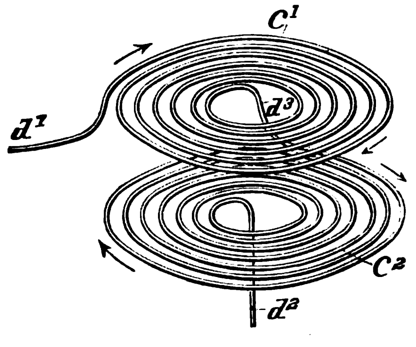

FIGURE 2.

In action this attractive force is variable by reason of the variations in the strength of the current which are caused by the action of the transmitter.

These variations cause vibrations on the part of the receiving instrument capable of producing sound waves or sonorous vibrations corresponding to those by means of which the current vibrations were originally occasioned.

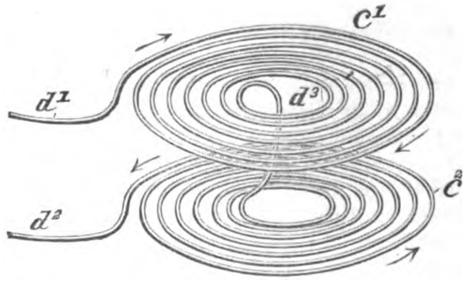

FIGURE 3.

A Hughes microphone with four contacts is used for a transmitter. The transmitter I shall use this evening has been used in my experiments for the past six months, without any adjustment, with from one to 30 cells of Fuller battery, under all conditions. On ordinary circuits, say up to two miles, four cells of Fuller battery are used at each terminal. On a 30 mile circuit measuring 400 ohms, 12 cells are necessary. In fact the battery is increased according to the resistance of the circuit and as the percentage of variation at the transmitter decreases. I will be able to demonstrate to you this evening that my telephone is about equal in loudness to the best modern magneto telephone. I think you will also find that its articulation is superior to any you have ever heard. Since it requires a battery current to work it properly, it does not respond to induced currents to any great degree; therefore it does not pick up all the neighboring currents and annoy the listener with the "frying" and crackling sounds present in magneto telephones in our large cities. For the same reason it works as well through an underground circuit as over a pole line. In fact I have the assurance to hope that I have solved the problem of underground telephony.

I will now let the instrument speak for itself.

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APPLICATION OF ELECTRICITY TO HOROLOGY.

BY CHARLES A. TERRY.

(Continued from page 92.)

II.

It will be convenient to consider the subject under the following divisions:

I. Electric Clocks.
II. Secondary Dials.
III. Synchronous Pendulums.
IV. Correcting Devices.

Electric clocks, strictly speaking, include those forms only in which electricity is employed as the motive power, and the clock-movement determines and controls for itself the supply of its maintaining power. Clock movements which are actuated by currents or impulses transmitted from a primary clock are more properly termed secondary clocks or dials.

The principal classes of electric clocks are *first*, those in which a maintaining impulse is imparted to a pendulum or balance-wheel at each beat or each alternate beat, and *second*, those in which electro-magnetic devices are employed for periodically winding a spring or weight. In the first class the impulses are sometimes given by the periodic attraction exerted by a magnet or a solenoid upon an armature, the one or the other being carried by the pendulum, as in the Bain system, but usually the impulses are given by a small weight or spring which is lifted or placed under tension by means of an electro-magnet, and released by the movement of the pendulum or balance-wheel. The comments made upon both classes by Beckett in his excellent treatise[1] are somewhat discouraging to one disposed to perfect the electric clock. Allowance, however, must be made for the author's obvious predilection for mechanical clocks, and consequent aversion for an interloping power in the form of electricity. Referring to the Bain system he remarks, "Nor would anything but the strongest evidence, independent of the inventor, convince me that any independent pendulum directly maintained by electricity can succeed in keeping good time for any considerable period." In speaking of the Shepherd clock, to the pendulum of which periodic impulses were imparted by a small gravity-arm lifted through the influence of electricity and allowed to fall on a pallet, like the down-pallet of a dead-escapement, Mr. Beckett adds, "but unfortunately it did not always lift, and any one who sets to work to invent electrical clocks must start with the axiom, that every now and then the electricity will fail to lift anything, however small." Notwithstanding these dire predictions many inventors have appeared, who, fully convinced of the practicability and utility of electric clocks, have cultivated the field until a result has been attained which would withstand Mr. Beckett's severe test without difficulty.

The Shepherd clock, above referred to, was shown at the London exposition in 1851, having been invented some two years before that time. It was first proposed to give the impulses by a spring wound by an electro-magnet and retained by a detent. The pendulum rod carries two pallets, one of which raises the detent and the other receives the impulses of the spring. The circuit through the magnet is completed by the pendulum at the extremity of its vibration to the left and the impulses are given at the extremity of the vibration toward the right. The pendulum is thus merely a measurer of time and a circuit-controller, and the amount of force imparted to it is independent of the battery strength. When a weight is employed the arrangement is similar.

An interesting form of clock, which appeared soon after this, is that invented by Prof. M. G. Farmer, then of Salem, Mass., about the year 1852. The principle of this clock is similar to that of the Shepherd clock, that is to say, equal impulses are imparted at regular intervals to a vibrating pendulum by the aid of a spring and an electro-magnet. Figure 2 illustrates the principle upon which

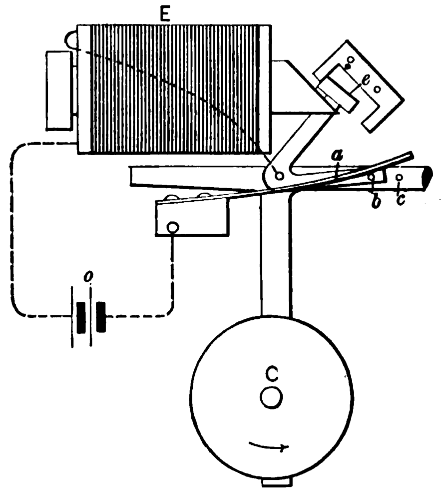

FIGURE 2.

the clock was constructed. The circuit of a battery o is closed through the magnet E by means of an impulse-spring *a*, and a lifting-pawl, *b*, carried by the armature, *e*. The electro-magnet being vitalized, the spring, *a*, is raised. The pendulum, c, by its swing toward the right hand carries a pin, *c*, attached thereto, against the impulse-spring, *a*, thus raising it out of contact with the lifting-pawl. The circuit of the battery, o, through the magnet, E, being thus interrupted, the armature and lifting-pawl fall away and the impulse-spring is free to press against the pin, *c*, and to aid the force of gravity in causing a return movement of the pendulum. In its descent the impulse-spring again comes into contact with the lifting-pawl, *b*. The circuit being thus again completed, the spring is raised and remains under tension until the operation is repeated at the return beat of the pendulum.

So great was the promise of this clock that Prof. Farmer obtained, in 1853, a charter to establish an electric-clock system in Boston. Unfortunately, however, his many other interests, especially the development of the fire-alarm telegraph, which taxed his time and energy to the utmost, prevented him from then devoting sufficient attention to the project to carry it into active operation.

It is interesting to notice to how great an extent this general form of clock found favor with other inventors. In 1854, Alexander Hall, of Ohio, invented a clock in which maintaining impulses are imparted to the pendulum near its axis of oscillation by a spring attached to the end of a horizontally vibrating lever. The lever carries two armatures, one upon each side of the pivot. Two electro-magnets act alternately upon the respective armatures, causing the lever to move in a horizontal plane, somewhat in the manner of a walking-beam. The circuit connections are controlled by the pendulum, while the movements of the lever give motion to the clock and at the same time furnish maintaining power to the pendulum. Mr. Hall further proposed to place secondary clocks in circuit with one of the electro-magnets and it is evident that the regularly recurring impulses would serve very well to drive the secondary clocks.

In 1863, Messrs. Hamblet and Edmands, of Boston, devised an ingenious method of completing and interrupting the circuit of the magnet which controls the impulse-spring. In this clock, like Shepherd's and Farmer's, the force of the impulse was not dependent upon the strength of the battery, it being requisite only that this should be sufficient to cause the electro-magnet to attract its armature.

An application of the equal-impulse idea to balance-wheel clocks was made by Robert Wear, in 1847, and by

1. A rudimentary treatise on Clocks, Watches and Bells, by Sir Edmund Beckett, Bart., London.

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Vitalis Himmer, about 1869. A spring moves the balance-wheel in one direction and an arm extending from an armature-lever acts counter to the spring. The movement of the balance-wheel controls the connection of the circuit through the electro-magnet. D. F. Sweet, of Michigan, and Elijah Clark, of Kentucky, several years later, devised other methods of applying the principle to balance-wheels. Much the same form of mechanism as was employed in his balance-wheel clock, Mr. Himmer adapted to a pendulum clock. The impulses, however, were imparted by small weights suspended by flexible cords. Later, Mr. Himmer made some important changes and improvements in this form of clock, one of which was to impart an impulse to the pendulum upon opposite sides alternately, thus rendering its vibration uniform. This is doubtless a much better plan than to impel it from one side only, for not only does it secure a more uniform vibration causing the amplitude to be the same in each direction, but it is more economical of power.

Among the many devices which now followed for imparting the impulses and for actuating the clock movement there should be mentioned that of Wm. M. Davis, of Cincinnati, Ohio, who, in 1871, invented a clock of the equal-impulse type, in which two pendulums are employed, one serving to control the circuit-connections and the other to impart the impulses to the first and at the same time to drive the clock-mechanism.

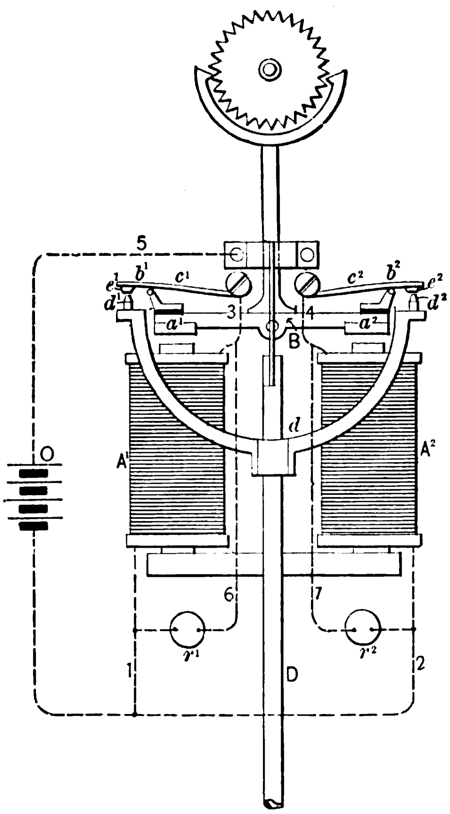

FIGURE 3.

In nearly all the clocks the impulses are imparted either each second or every two seconds. Some inventors, however, for instance, John Happersberger, of Ohio, proposed to impart the maintaining impulses once each minute. This he accomplished in 1879 or 1880 by mounting upon the pendulum rod a toothed-wheel carrying a circuit-closing pin. The wheel is revolved step-by-step by the vibrations of the pendulum and once in each revolution it places the pin in position to complete the circuit by being carried between two contact-arms. An impulse is thereupon given to the pendulum from a spring placed under tension by the action of the magnet.

It is quite impracticable to even refer to all the different modifications in which this method of actuating clocks presented itself, but having indicated the general lines pursued, it will be sufficient to mention particularly the clock which now promises to prove entirely satisfactory in its operation and especially suited to be employed as the regulator of an electric-clock system. This is the clock now in use by the Time Telegraph Co., of New York, and it is constructed essentially upon the plan proposed by A. S. Crane, of Newark, N. J., but somewhat modified by C. H. Pond and H. L. Bailey, of New York. This clock involves the giving of an impulse to the pendulum at each beat; the accomplishment of the same in such a manner that the force of the impulse is always the same; an arrangement of contact-points which not only insure good electrical connections but also afford little opportunity for irregularity in the imparting of the impulses; and finally an organization of circuits adapted to reduce the liability of the occurrence of sparks or electric discharges at the contact-points. The diagram, figure 3, will serve to illustrate the principle of this invention. Two electro-magnets, A1 and A2, are included in branch conductors, 1 and 2, leading from a battery O. A lever, B, carries the respective armatures, *a*1 and *a*2, of the magnets. A conductor, 3, leads from the magnet, A1, to an insulated impulse spring, *c*1, and a conductor, 4, leads from the magnet A2 to a similar spring, *c*2. Upon the pendulum, D, there is carried a cross-arm, *d*, which is connected with the battery, O, by a conductor, 5. Each spring carries a knife-edge contact, *e*, and these are respectively applied to two similar contacts, *d*1 and *d*2, upon the arm, *d*, the faces of the same crossing each other at right angles. The movement of the pendulum causes either the contact, *d*1 or *d*2, to strike its corresponding contact, *e*1 or *e*2, and the corresponding magnet becomes vitalized. When the magnet, A1, is thus vitalized, the armature, *a*1, is drawn down and an insulated lifting-pawl, *b*2, carried on the lever raises the spring, *c*2. This spring remains thus under tension until the swing of the pendulum in the opposite direction brings the point, *d*2, against the point, *e*2. At the moment of this contact or else immediately before, the point *d*1 leaves the point *e*1. The circuit is thus transferred from the magnet A1 to the magnet A2, and the lever is thus tipped in the opposite direction. The spring, *c*2, acts then through the contacts *e*2 and *d*2, to impel the pendulum back, and meanwhile the spring, *c*1, is raised, preparatory to imparting its impulse when the pendulum has completed its vibration in that direction. Small artificial resistances, *r*1 and *r*2, are usually included in conductors 6 and 7, leading around the coils of the electro-magnets for the purpose of allowing the magnets to discharge readily and to prevent sparks at the contact-points.

It will be noticed that in the clocks thus far considered a spring or a weight is placed in position to act through the agency of electro-magnetism; in other words, power derived from the electric current or impulse is temporarily stored up in a mechanical form. Upon reflection it will be evident that there are other ways of employing the power than by imparting impulses to the pendulum, as for instance, by applying it to the clock-train and controlling the movements of the latter by a mechanical escapement. That is to say, the spring or weight may act precisely as in a mechanical clock, being wound or placed under tension by electricity. A very good example of this is found in the clock of W. D. Whalen, of Michigan, which was patented about three years ago. A clock or watch-spring has its outer end attached to a ratchet-wheel and its inner end to the arbor of the scape-wheel. An electro-magnet which is vitalized at each alternate beat of the pendulum, acts through its armature-lever and a driving-pawl to advance the ratchet-wheel, thus carrying forward the outer end of the spring and winding the same. Meanwhile the inner end of the spring is allowed to advance by the movements of the ratchet-wheel, thus tending to unwind the spring, but the winding keeps pace with the unwinding and the

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spring having at first been placed under tension, there will always be sufficient actuating power stored in the spring. It is obvious, however, that any failure on the part of the electro-magnet to actuate its armature must result in a diminution of the power stored, which could not be regained if the clock were constructed to wind the spring with the same rapidity with which it unwinds, and after a few such failures the clock would necessarily stop. This element of weakness appears to have been discovered at a very early date, for in an English paper, the Bath and Cheltenham *Gazette* of May 1st, 1844, there was published a description of a "Remontoir Electrical Clock," from which the following is an extract:—

"A galvanic clock of novel and complete character has just been completed by Mr. Wadham, of the Abbey Green, for a gentleman in the neighborhood of this city. A small 'Smee's battery' appears sufficient to maintain the clock in action for many weeks, a fresh charge of diluted acid being given once in about 14 days. The clock is put in motion *manually*, by the action of a lever on a coiled spring. It is the office of the galvanic current to continue this motion. The current periodically vitalizes an electro-magnet which, acting upon the armature, advances a ratchet-wheel. The revolution of the ratchet-wheel imparts power to a spring, which not only sustains the original impulse given to the machinery but *accumulates* it. This accumulated power, whilst provision is made for its never exceeding a certain amount, subserves two or three valuable purposes:—The varying power of the battery (provided it supplies enough to maintain the original momentum) does not affect the time-keeping; neither is it of any consequence if the accidental presence of a particle of dust at the contact-former prevent the contact being made regularly every second; and, lastly, the clock is so far *rendered independent of the battery itself* that it will continue to go correctly for above a minute *after the battery is removed;* thus providing ample time to change the battery or to renovate it by a fresh charge of diluted acid. In short, this beautiful piece of apparatus scarcely leaves anything to be desired in the construction of a galvanic clock."

The correspondent, however, seems to have been over-sanguine in his estimation of this clock, judging from the number of inventors who have since labored in the same direction, and many different ways of storing and applying the power were presented before the invention of Whalen's above referred to, some applying the circuit controller to a pendulum, others to some moving portion of the clock train and still another by bringing the battery into operation periodically. This last invention referred to is that of J. W. Wignall, of England. The descent of the clock-weight to a certain point sets free a catch which, in one instance, causes the zinc plates of the battery to drop into the solution and in another instance the solution to rise about the plates. In either case the winding of the weight immediately commences and at its completion the parts resume their former relative positions.

The only remaining clock which it comes within the province of the present article to describe is that recently patented by Chester H. Pond, of New York. This is very ingenious and withal a very complete device adapted to be operated either as a primary electric clock or a secondary clock or dial. The fundamental point of difference between this and earlier forms of clocks of the character last considered, lies in the employment of an electric motor having a rotary armature for accomplishing the winding instead of the usual reciprocating or hinged armature. The train is provided with a device which completes a circuit through the motor once an hour, and this circuit remains completed until the spring, which is capable of driving the clock for something more than an hour, is fully wound, whereupon the circuit is interrupted and the clock continues to operate in the manner of any ordinary clock for the next succeeding hour. The advantages of employing the rotary motor are obvious, for instance, the movement being constantly in one direction there is no lost momentum when once it is started, and again the rapidity with which it winds the spring is another desirable feature. The application of this class of motor, obvious as it would seem in view of what had already been done, appears to have been entirely overlooked by all the other inventors, but by its means Mr. Pond seems to have more nearly approached the ultimate solution of the general problem than any of his predecessors.

(*To be continued.*)

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 125.)

If poles are strong enough to do their work, and if good wires are employed there is little danger of wires breaking across a highway; but at the same time it is wise to avoid all unnecessary crossings as accidents will happen, and a sharp frost or a heavy sleet storm may break down the best of lines. In some countries this is regarded as such an important point, that oblique crossings are not permitted at all, and where crossings are absolutely necessary, the poles on the opposite sides of the road are required to be immediately opposite one another. This seems to be rather an excessive caution.

Another question to be considered is the height of poles. Through the country for a line of but few wires—say one to six, a 25 foot pole seems to be quite long enough, and a good rule is to make 20 feet the minimum distance between the lowest wire and the ground. If the poles have to be set unusually wide apart, it will be better to add a couple of feet to the length as the dip at the centre of the span will be considerable. In cities, and at road or railway crossings as also where there are trees, the length will necessarily depend on the surroundings, and the judgment of the constructor must here be called into play. It is good practice to avoid sudden extremes in passing from long to short poles or vice versa, and the rise or fall should be made gradual so as to present a symmetrical appearance.

How many poles should be used per mile? This again depends absolutely on the conditions to be complied with. For one or two wires through a straight and clear section of country I would not use more than 25 poles to the mile, while if the surface of the country is rolling, and the curves and crossings abundant, it may be necessary to increase to as high a number as 35 to the mile. The average number throughout the country is probably about 30 to the mile. Ordinary poles such as these, should never have a less top diameter than five inches, and the longer a pole is the stouter it must of course be.

POLE SETTING.

Supposing now that the line of route is decided upon, and the poles purchased and prepared; the next thing is to have them delivered and distributed. If the line is to have 25 poles to the mile, a pole must be dropped about every 70 yards. If men are plentiful, it may be well to have one set of men go ahead to dig the holes, while another squad follows close to do the planting. It may seem to be a very simple thing to dig a hole properly, but none the less it is one of those minor operations which have to be more closely watched than greater ones. Not long since a case came under my notice wherein it was found that after a section of line was built by contract, the poles, which were at least 30 feet high, were planted in holes scarcely two feet deep; a circumstance which proves that even a hole for a telegraph pole should not be trusted to a contractor. Holes should always be dug with their length in the line of the wires, so that the smallest part of the loose earth after filling the hole, shall be in the line of lateral strain. If work is let

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out to contractors, a proper inspector should in all cases be present to see that it is properly done. How deep then should poles be set? I should say, under no circumstances to a depth less than five feet. I am aware that it is customary to make four foot holes serve for 25 or 30 foot poles, but it is not good practice. A hole five feet deep will do for all poles 35 feet long or under (of course for temporary work, no such depth is essential), and as the poles increase in length the holes should increase in depth. All poles before being set should have a mark put on them a definite distance from the butt end, so as to indicate when set the depth of the hole.

In digging, the tools which are found the most universally convenient, are the pick, the ordinary shovel, the spoon shovel, the digging bar; and in some localities where the soil is soft and friable a variety of spoon like a short funnel, or a suction pump bucket is also very useful. This, as well as a two bladed scoop or spoon, rigged up with a swivel, ice-tongs fashion, are much used in the south. Through a rocky country, blasting appliances are also found necessary. In addition to all these, where the soil is light, time can often be gained by using a boring tool, or post auger. This tool has a cross handle and is worked by two men who walk round pushing the handle in front of them. To work it easily it must be lifted out and cleared of the loose earth, quite frequently. It has also the additional disadvantage that it cannot be worked near a wall or fence, but needs a clear sweep for the operators to work, but it makes a nice compact hole. Holes must be kept as near the size of the pole butt as possible, but if deep, may be widened in one direction—that of the line—at the surface, or even dug in steps on one side, but this is simply a concession for the sake of greater ease in setting the pole. On the whole my individual preference is simply for the pick, shovel, digging bar and spoon. Poles of ordinary size can easily be lifted into the holes; but for very large ones, a shears or derrick is required. As soon as a pole is placed in the hole, it must be turned round, to the position it is required to stand in; if only brackets are attached, these should be on the side away from the road. If crossarms, they should be sighted so as to stand directly at right angles to the line of the roadway.

At crossings, curves and corners, the pole must be so twisted, that the strain of the wire will press against the pole and not away from it. Wherever the roadway is straight, the pole may and should be set quite upright, but on curves, they ought to be set a little aslant so as to lean back against the strain.

The next thing to consider is the "tamping" or as they call it in England, the "punning." This is another of the minor operations which is often done carelessly, but which really demands great care.

Only a little of the earth should be thrown in at once, and this is to be well tamped before any more is to be put in. Stones put in the hole close to the pole aid in supporting it. On the faithfulness exhibited and care expended in tamping, the permanency of the line in a great measure depends. The earth ought to be banked up round the pole, as this prevents the formation of depressions which would tend to hold water, at the earth line. It is always well to let the poles stand a while and settle, before the wire is strung, because their strain tends to pull the pole out of place.

LIGHTNING RODS AND LEAKAGE CONDUCTORS.

In some parts of the country, lines are when unprotected, continually exposed to danger from discharges of lightning. In such districts, the poles are fitted with lightning rods, which extend 18 inches or two feet above the top of the pole. No. 8 galvanized iron serves very well for this purpose, and it can be fastened directly to the pole by strong staples. Figure 10 shows the general arrangement adopted, which is found to answer well, although the side extensions, or branches to the insulators are only used on a few poles on both sides of a station.

The best way to make earth for these rods when they are used, is to procure a sheet of galvanized iron and thread the No. 8 wire, through holes prepared in it, soldering the connections thus formed at each hole, and then before putting any earth in the hole, bending the plate so as to form a loose sleeve around the pole, of considerable surface.

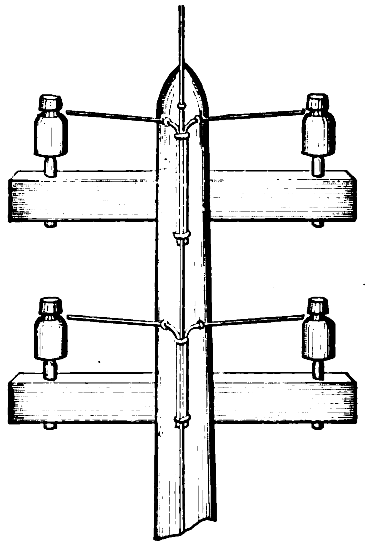

FIGURE 10.

This can be still further improved by letting a loose leaf of the iron sheet lap over the bottom of the hole, so that the iron not only surrounds, but is also under the pole when set. In ordinary soil a good earth plate is thus made.

In England almost every pole is furnished with an earth wire, arranged as shown in figure 11.

The rod is attached to the pole before it is set, and the ground end is formed into a flat helix or volute placed under the foot of the pole. I have measured the resistance of both of the earth connections which I have here described and have found the plate to be uniformly the lowest. In addition to the use of these devices as lightning guards, they have still another use. It is quite impossible especially in wet weather to so insulate wires, that no electricity shall escape from them. When two or more wires are stretched on the same poles, whatever current escapes from any of them, will of course divide itself among the routes open to it. The several routes, are first, by the pole itself direct to earth; and second by the way of the other wires to earth at other points. Now the portion escaping via the pole, does not cause any special inconvenience, as its only result is to weaken the signals on the leaky wire; but the portion which escapes on to the other wires sometimes proves a great nuisance, as it interferes with the signals passing over them. Much of the so-called "induction" on telephone lines is due most certainly to absolute leakage, and when this leakage is heavy, the contact conductor or earth wire is useful and its function is to intercept the leakage and conduct it direct to earth.

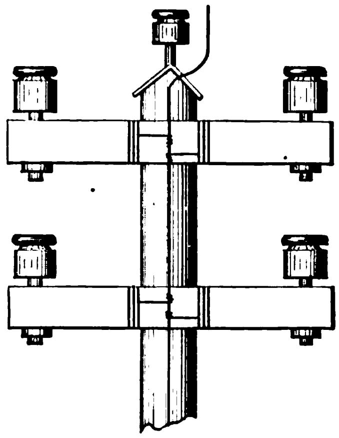

FIGURE 11.

On short telephone lines—say for those not exceeding 15 miles in length, this device has proved useful. For longer circuits the capacity of the lines is so increased that retardation due to static induction is plainly perceptible, being due to the near proximity of the earth, which by means of the rods is virtually brought close up to the line-wires. Therefore, while under certain conditions the earth wires are advantageous, I do not advocate their employment, except when rendered necessary by the prevalence of lightning storms. Moreover, unless a good ground can be obtained, it is far better to have none; because if a rod of metal runs down a pole, and does *not* make good earth, it only operates to attract the atmos-

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pheric discharge, which, finding difficulty in passing off, destroys the pole.

So far as the use of the rod as a contact or leakage conductor is concerned, it would seem that the method of preventing interference between conductors by carrying the interfering currents to earth, is but a makeshift, and we fully agree with Pope in his opinion written years ago, that "a much more economical and effective method of obtaining this result, is that of improving insulation." Poles as well as housetop fixtures, need guying against any side strain, such as occurs at corners and on sharp curves. For a line of from one to six wires, a guy or stay wire should be composed of about three No. 8 iron wires, and the distant end of the guy may be fastened to a tree if one is convenient, or to any adjacent fixed object.

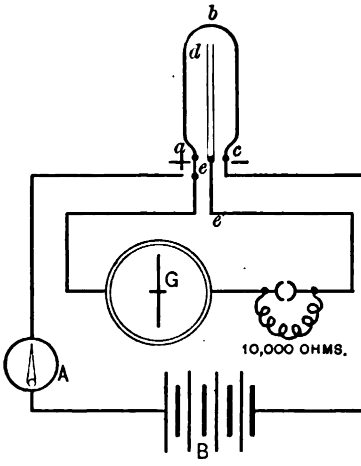
(*To be continued.*)

ON A PECULIAR BEHAVIOR OF GLOW-LAMPS WHEN RAISED TO HIGH INCANDESCENCE.[1]

BY WILLIAM HENRY PREECE, F. R. S.

1. During my recent visit to America (October, 1884) Mr. Edison showed me a very striking experiment with glow-lamps, the principle of which he had not threshed out, although he had attempted to apply it practically to the regulation of the current flowing in electric light circuits.

Fig. 1



If *abc* be the incandescent filament of a glow-lamp, *de* a thin narrow platinum plate fixed between the limbs of the filament with an independent wire connection *ee'* sealed in the glass globe, then, if a galvanometer G be connected between *a*, the positive electrode, and *e*, a derived current will be observed to pass through G, and through the rarefied space *ec* when the main current is increased to a certain strength, and the filament reaches a certain degree of incandescence. The strength of this derived current will increase with the increased brilliancy of the flowing filament. Mr. Edison made for me several lamps of different forms and character to enable me to investigate the phenomenon more carefully in England, and I have the pleasure of submitting the results of those experiments to the society.

2. I used 60 Faure-Sellon-Volckmar cells freshly and fully charged up at each series of experiments. The current through the filament was measured by a specially constituted and calibrated Ayrton and Perry direct-reading spring ammeter. The galvanometer in the shunt circuit was a sensitive tangent galvanometer of the post-office pattern. The current through the filament was regulated by varying the number of cells. The current and electromotive force through the shunt *ae* were calculated by the following method :—The resistance of the galvanometer G was 1070 ohms, and a variable resistance R was inserted in its circuit. When the current from a standard Daniell cell (1·07 volt) is sent through the galvanometer, we get a tangent reading *d*, which, since $\frac{1·07}{1070} = ·001$, is the deflection, or tangent reading corresponding to 1 milliampère of current. The deflection (d_1) given by the shunt current was first read without any resistance being inserted.

Hence

$$C = \frac{d_1}{d} \text{ milliampères.}$$

Resistance was then added and a second reading d_2 taken ; then the resistance *r* of the shunt is obtained from the formula

$$r = R \cdot \frac{d_2}{d_1 - d_2} - G.$$

The electromotive force producing the current is

$$E = Cr.$$

The shunt circuit includes the rarefied space *ec*, and it is the resistance of this space that we desire to know.

All the observations were simultaneously made by different observers. While one observed the behavior of the lamp, another read the current flowing through the filament, a third read the currents in the shunt, a fourth varied the electromotive force, and a fifth recorded the results. The electromotive force of the cells was carefully measured before and after the experiments. No photometric measurements were attempted.

3. *Experiment* 1.—The connections were made as shown in figure 1. The lamp (No. 4) was a short (75 mm.) filament lamp, with a platinum plate 30 mm. long and 5 mm. broad.

EXPERIMENT 1.

Filament.			Shunt.			Remarks.
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères.	Resistance.	
		ohms.	volts.			
44·40	0·7	63·4				
46·62	0·75	62·17	..	..	..	Normal incandescence, viz., 8 candles.
48·84	0·81	60·30				
51·06	0·86	59·37				
53·28	0·91	58·55	14·7	0·30	49,000	
55·50	0·97	57·21	..	..	..	Diffused blue effect in globe appeared.
57·72	1·02	56·60	16·6	1·15	14,500	
59·94	1·08	55·50	16·2	1·80	9,000	
62·16	1·13	55·01	13·5	2·70	5,000	
64·38	1·20	53·66	11·95	3·85	3,000	
66·60	1·24	53·71	7·45	5·25	1,400	Blue effect brilliant.
68·82	1·24	55·51	10·00	5·00	2,000	
71·04	1·30	54·65	9·10	6·00	1,300	
73·26	1·35	54·28	6·50	5·00	1,300	
75·48	1·35	55·92	9·35	5·50	1,700	
77·70	1 41	55·12	9·60	6·00	1,600	
79·92	1·47	54·38	9·80	7·00	1,400	
82·14	1·60	51·34	critical point			Deflection too unsteady for observation. Blue effect very brilliant.
84·36	1·60	52·74				
86·58	1·58	56·59				
88·80	1·56	57·00	50·6	2·20	23,000	
91·02	1·58	59·30	62·5	2·50	25,000	
93·24	1·57	59·40	61·0	3·20	19,000	
95·46	1·60	59·51	95·0	3·80	25,000	
97·68	..	..	..	..	..	Filament broke. Interior of globe and faces of plate blackened.

The variation of the current and the increase in the resistance of the filament towards the end of the experiment, together with the behavior of the shunt, are very noticeable. It is quite clear that when the electromotive force attained 82 volts, a critical point was reached. From that point the current in the filament remained very steady, but the resistance gradually increased. The shunt increased

1. From the Proceedings of the Royal Society, March, 1885.

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in resistance enormously, and the current through it diminished, although the electromotive force increased very largely. It is remarkable how steady the electromotive force in the shunt remained until the critical point was reached, when it suddenly increased and only reached that of the main current at the point of rupture of the filament. Again the current, which steadily increased until the critical point was reached, then diminished, indicating a considerable increase in the resistance of the rarefied space *ec*. In one subsequent experiment, after the critical point was reached, no current could be obtained through the shunt.

The direction of the current is shown in the figure.

Towards the end of the experiment, when the characteristic diffused blue effect in the globe was very marked, a bright arc was observed to be playing about the bottom of the limb at *c*, and it was quite clear that a bridge of conducting material was formed between *e* and *c*, which, together with the galvanometer, made a shunt to the filament.

This experiment was repeated upon different lamps, and the results were so similar that it is not necessary to reproduce the observations.

In all cases an intimate connection was observed between the blue effect and the appearance of the shunt current.

4. One of Mr. Edison's assistants showed me, in Philadelphia, that while the effect was very perceptible when the connections were made as shown in figure 1, *a* being in connection with the positive and *e* with the negative pole, no shunt current or a very slight one could be observed when the direction of the current was reversed. I did not find this invariably the case. One lamp (No. 8) only—a long filament lamp (150 mm. long)—which gave a marked shunt current and the blue effect, when the connections were made as in figure 1, failed to give any current or blue effect when the current was reversed within the limits of the electromotive force at my command. Doubtless I should have got both effects if I could have raised the electromotive force. In all cases, however, the effects appeared sooner and were more marked when the connections were as shown in figure 1 than when the direction of the current was reversed. The effect of placing the galvanometer between *e* and *c* was the same as reversing the current.

5. As the effect might be due in some way to the material of the conducting plate, *de*, inserted between the limbs of the filament, Mr. Edison made for me lamps with copper, iron, and carbon plates.

The following experiments were then made, the connections being the same as figure 1 :—

EXPERIMENT 2.—CARBON CENTRE (SINGLE).

Filament.			Shunt.			
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères.	Resistance.	Remarks.
		ohms.	volts.			
80	0·50	160·0				
84	·57	147·4	..	0·98		
88	·60	146·7	5·44	0·54	99,000	
92	·65	141·6	4·76	1·22	39,000	
96	·70	137·1	27·7	2·20	12,600	
100	·74	135·1	25·4	3·42	7,420	Blue tinge appeared.
104	·79	131·7	21·4	4·88	4,380	
108	·83	130·1	17·5	7·32	2,390	
88	0·60	146·7	08·23	0·46	179,000	Reversed the current
92	·65	141·6	04·86	0·93	52,300	through the filament and
96	·70	137·1	26·0	1·76	14,800	repeated the experiments.
100	·74	135·1	21·1	2·93	7,190	Blue tinge appeared.
104	·79	131·7	19·1	4·45	4,300	
108	·83	130·1	17·5	7·32	2,390	

EXPERIMENT 3.—IRON CENTRE (SINGLE).

Filament.			Shunt.			
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères.	Resistance.	Remarks.
		ohms.	volts.			
80	0·50	160·0				
90	·57	157·9				
96	·62	154·8	..	0·25		
100	·66	151·5	..	0·49		
110	·77	142·9	31·4	2·05	15,300	
120	·87	137·9	19·8	5·85	3,380	Faint blue.
90	0·57	157·9	..	0·09	..	Reversed the current
100	·66	151·5	..	0·49		through the filament and
110	·77	142·9	27·3	1·95	14,000	repeated the experiments.
120	·87	137·9	20·0	5·61	3,560	Faint blue.

EXPERIMENT 4.—COPPER CENTRE (SINGLE).

Filament.			Shunt.			
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères.	Resistance.	Remarks.
		ohms.	volts.			
80	0·57	140·4	..	0·048		
90	·67	134·3	39·2	1·12	35,000	
100	·79	126·6	19·0	3·80	5,000	Faint blue.
110	·90	122·2	..	needle hard over	..	Strong blue.
90	0·67	134·3	29·9	0·88	34,000	Reversed the current through the filament and repeated the experiments.
100	·79	126·6	17·2	3·32	5,190	Faint blue.
110	·90	122·2	..	needle hard over	..	Strong blue.

No marked difference was thus observable.

If we examine the shunt current when the faint blue tinge appeared, it was : with carbon, 3·42 ; with iron, 5·85 ; and with copper, 3·80 milliampères.

6. It might be affected by the extent of surface of the metal plate, therefore lamps were made with a plate of fine wire, and also of a very broad surface, but no difference was observable between these and the normal plate used.

7. Lamp No. 9 was made with a double platinum plate, thus (see figure 2):

Fig. 2

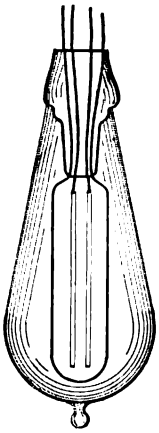
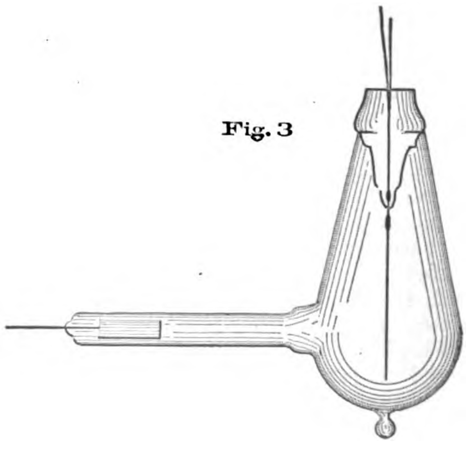


Fig. 3



The following experiment shows that no perceptible difference was observable:—

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EXPERIMENT 5.—NO. 9 LAMP (DOUBLE PLATINUM).

Filament.			Shunt.						Remarks.
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F. Left.	Calculated E. M. F. Right.	Current in milliampères Left.	Current in milliampères Right.	Ohms. Left.	Ohms. Right.	
		ohms.	volts.	volts.					
80	0.56	142·9	5·46	5·46	0·39	0·39	140,000	140,000	
84	.60	140·0	3·8	3·8	0·83	0·83	45,700	45,000	
88	.65	135·4	24·5	24·5	1·56	1·56	15,700	15,700	
90	.68	132·4	20·5	20·5	2·05	2·05	10,000	10,000	
94	.72	130·6	16·2	16·2	3·27	3·27	4,950	4,950	
100	.79	126·6	15·4	15·4	5·85	5·85	2,630	2,630	Slight blue tinge perceptible.
110	.92	119·6			Doub	tful.			

8. Although the maximum effect was produced by Mr. Edison when the plate was fixed between the limbs, he obtained a current when it was fixed in any part of the rarefied space. If the effect was due primarily to the Crookes effect, or to the projection of molecules from the carbon filament on to the metal plate, since this bombardment takes place in right lines, we ought to have obtained effects when these lines were projected on the plate, but no effects when they could not strike the plate. Several lamps were made which are shown in the different sketches.

9. The metal plate was taken from between the limbs of the filament, and placed at the end of a tube which had a portion of the filament exposed to the plate.

EXPERIMENT 6.—NO. 5 LAMP.

Filament.			Shunt.			Remarks.
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères	Ohms.	
		ohms.	volts.			
50	......	......	......	......	......	a +, c—, Fig. 1.
60						
70	0·55	127·3				
80	0·65	123·1				
84	0·70	120·0				
86	0·73	117·8				
88	0·75	117·3				
90	0·77	116·9				
92	0·80	115·0				
94	0·82	114·6				
96	0·85	113·0		No cur	rent.	
98	0·87	112·6	......	......	......	Blue effect visible in bulb.
100	0·89	112·4				
102	0·93	109·7				
104	0·96	108·3				
106	0·99	107·1	......	......	......	Blue effect strong in bulb; none in tube.
108	1·01	106·9				
110	1·05	106·7				

Reversed the current through the filament. Returned to 90 volts, and repeated the experiments. Filament current readings the same as before, and also the blue effects. At 108 volts a slight blue effect was noticed in the open end of the tube.

RECOMMENCED EXPERIMENT WITH 100 VOLTS.

Filament.			Shunt.			Remarks.
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères	Ohms.	
		ohms.	volts.			
100	0·89	112·4	......	......	......	a +, c—, Fig. 1.
102	0·93	109·7				
104	0·96	108·3	......	·049		
106	0·99	107·1	......	·049		
108	1·01	106·9	......	......	......	Blue effect entering tube.
110	1·05	104·7	......	·073		
112	1·07	104·7	......	·146		
114	1·11	102·7	......	·195		
116	1·14	101·8	......	·24		
118	1·18	100·0	11·3	·39	29,000?	Deflection too low to enable resistance to be properly measured.
120	1·22	98·36	10·9	·49	22,300	

Doubtless, if I could have increased the electromotive force the results would have been more marked; but they were sufficient to show that the effects were evident, even though the rarefied space were greatly extended, as in the case of the tube attached to No. 5 lamp.

10. The tube was constructed so that no portion of the filament was opposed by right lines to the metal plate.

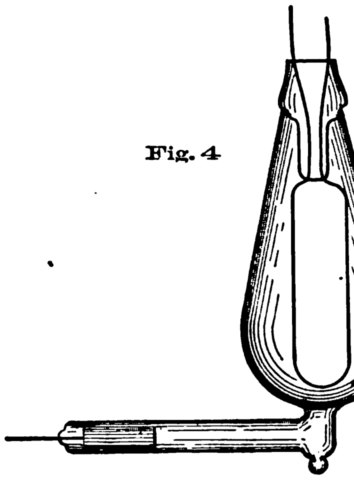

Fig. 4

EXPERIMENT 7.—NO. 6 LAMP (LONG FILAMENT).

Filament.			Shunt.			Remarks.
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères	Ohms.	
		ohms.				
76						
80	0·57	140·3				
84	0·60	140·0				
88	0·65	135·4				
92	0·71	129·6				
96	0·75	128·0				
100	0·80	125·0	......	......	......	Faint blue in globe.
104	0·84	123·8	......	·049	Deflections too low to enable resistance to be measured.	
108	0·89	121·3	......	·085		
112	0·94	119·1	......	·10		Blue in globe very marked.
116	0·99	117·2	......	·073		
120	1·06	113·2	......	·20		Bulb hot, tube cool.

11. A lamp was constructed with three branches at right angles to each other, as shown in figure 5, and each metal plate taken in succession, but no results were obtained.

EXPERIMENT 8.—NO. 7 LAMP.

Filament.			Shunt.			Remarks.
Volts.	Ampères.	Calculated resistance (hot).	Calculated E. M. F.	Current in milliampères	Ohms.	
		ohms.				
80	0·56	142·9				
90	0·66	136·4				
100	0·77	129·9	......	......	......	Blue effect in globe visible.
102	0·79	129·1		No current evident	in either section.	
104	0·82	126·8				
106	0·84	126·2				
108	0·86	125·6				
110	0·89	123·6				
112	0·91	123·1				
114	0·94	121·3				
116	0·98	118·4				
118	1·00	118·0				
120	1 02	117·7				

12. Professors Liveing and Dewar ("Proc. Roy. Soc.," March 9, 1882) observed a "sort of flame" during high incandescence, showing by its spectrum the presence of car-

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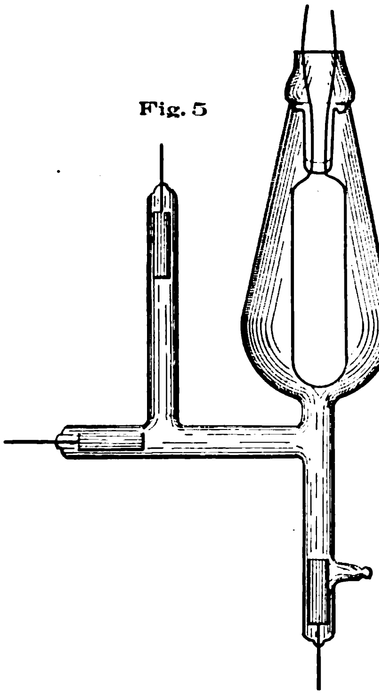
bonic oxide. It was strongest about the junction of the carbon thread and the positive electrode. It was, according to them, the glow of the positive pole attending a discharge in rarefied gas.

It is a common thing with glow-lamps, which have the heels of the filament close together, to have an arc forming across when the electromotive force at the terminals is too high. Hence in recent lamps requiring 100 volts, Mr. Swan has considerably increased the distance between the electrodes. Moreover, whenever the incandescence of the filament is raised beyond a certain limit, the interior of the glass envelope is blackened by a layer of carbon, which has been deposited by a Crookes bombardment effect. When the carbon filament is fixed on copper electrodes, the interior of the glass sometimes becomes coated with copper as well as with carbon, and the line between the two is perfectly marked, showing that the bombardment takes place in right lines. Experiments show how very high the electromotive force can be carried, if it be steadily and rapidly increased, before the filament is broken; but practice shows that when once the blue effect appears, destruction is only a question of time. Hence the blue effect is an indication of the advent of disintegration, and a very useful warning of danger ahead.

Fig. 5



13. Now it is clear that we have a combination of the phenomena above described in the Edison effect. A continuous bridge of molecules is formed between the junction of the carbon filament and the metal plates inserted between its heels. They are found deposited on the metal plate. A shunt is thus formed whose resistance is measurable, and a definite current passes. This shunt is formed just where the negative metallic connection joins the heel of the carbon filament, as we should expect from the investigations of Mr. Crookes. The current is, however, weak and variable, and it is scarcely reliable enough to be useful for practical purposes, as was hoped by its discoverer. When the critical point is reached the blue glow and flame seem to pervade the whole bulb, and the arc-like effect, instead of playing about the heel, surrounds, apparently, the whole filament. The result is that the current passes through the galvanometer and through the rarefied space. This is clearly shown in experiment 1.

14. It is quite clear that the critical point is reached when the filament commences to be disintegrated by the projection of its molecules from its surface. It is here that the resistance of the filament commences to increase, and the law of radiation and light emission ("Proc. Roy. Soc.," No. 229, 1884) commences to be departed from, as was shown by me in a paper read before the British Association at the Montreal meeting.[2]

15. It is very evident that this Edison effect is due to the formation of an arc between the carbon filament and the metal plate fixed in the vacuous bulb; that this arc is due to the projection of the carbon particles in right lines across the vacuous space; and that it makes its appearance earlier, and is more strongly marked, when the connections are as shown in figure 1 than when they are reversed, because, as Mr. Crookes has pointed out, the projection proceeds from the negative to the positive pole, and it would commence at the point of least resistance. Its presence is detrimental to the life of the lamp, and as its appearance is contemporaneous with the blue effect, the latter is a warning of the approach of the critical point, and a sure indication that the electromotive force is dangerously high. It is also clear that as the Edison effect is only evident when we are "among the breakers," it is not available for practically regulating the conditions of electric light currents as its ingenious discoverer originally proposed.

FRENCH TELEGRAPH WIRES.

The French telegraphic system is constructed almost exclusively with galvanized iron wire of 3 mm., 4 mm., 5 mm., and 6 mm. in diameter. The 3 mm. wires are used in the construction of the "departmental" lines; the 4 mm. wires, which are the most frequently employed, serve for the long main lines of communication; the 5 mm. and 6 mm. wires are employed to connect Paris with certain large towns, and with the frontier and foreign capitals. The conditions under which these wires are accepted by the government engineers and which include tests of their electrical and mechanical resistance, of the thoroughness of their galvanizing and of their tensile strength are determined by an official schedule. The wires most extensively used, are furnished by the works of Messrs. Paul Jamin & Co., of Eurville, the Société des Forges de Franche Comté, and the Société de Comneutruy-Fourchambault. The following tables give the various coefficients for these two series of wires :—

TABLE I.—JAMIN & CO.'S WIRE.

Diameter, mm.	7	6	5	4	3	2	1
Weight of bundles, lb.	339	330	330	328	244	154	75
Length, ft.	1680	2236	3110	4025	6726	9720	18,250
Number of deflections	4	5	5	7	12	9	19
Breaking weight, lb.	3272	2941	1664	1080	564	340	108
Extension at rupture, per cent.		180	105	140	150		

TABLE II.—THE SOCIÉTÉ DES FORGES DE FRANCHE COMTE'S WIRES.

Diameter, mm.	7	6	5	4	3	2	1
Weight of bundles, lb. (without joints)	92	85	81	79	72	66	58
Number of deflections	2	4	5	6	13	20	26
Breaking weight, lb	3351	2469	1719	1267	639	302	73
Extension at rupture	20	24	24	25	55	50	50
Elastic limit	2866	2204	1543	992	551	275	66

2. In this paper I pointed out from experimental data that the light emitted by a glow-lamp varied apparently as the sixth power of the current. I verified this law, not only by subsequent experiments of my own, but, which is much more satisfactory, by experiments of others. Professor Kittler, of Darmstadt, and Captain Abney made, independently of each other, most careful and exhaustive measurements in this direction. I tabulated and traced them out in curves. They fully confirm the law that

$$L = kC^6,$$

but within limits, and that these limits embrace the ordinary range of a glow-lamp when used for artificial illumination. As long as the resistance and the current vary uniformly together the law holds good; but as the state of incandescence is increased a point is reached, varying with each kind of lamp, when the resistance ceases to diminish at the same rate, and eventually to increase. When this occurs the law is departed from, and the light emitted increases much faster than the sixth power of the current. The filament speedily breaks. The point of departure from the law indicates a point when a change of state occurs in the carbon filament. Disintegration probably sets in. This point ought to be determined for each kind of lamp, and it should never be allowed to be reached, for it is from this point that decay commences and rupture follows.

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THE DISTRIBUTION OF ELECTRICITY.[1]

When first I was asked to give this course of lectures on "The Distribution of Electricity," I thought it would be an interesting thing, just in a general and somewhat popular manner, to give a description of the different schemes which have been proposed for lighting large installations and central station lighting, and to simply treat what had already been written in a general sort of manner. But as soon as I began to go into the question at all I felt it would be losing an opportunity for doing something which would really be far more useful, and that was to take up the subject from a more technical point of view than that which I had originally thought of, and to discuss somewhat fully these different systems, and explain the defects of each and what were the relative merits of them, and really to go into the question in a more thorough manner than anyone has found it worth his while up to the present time to attack these problems in.

ELECTRIC LIGHTING CIRCUITS.

This then is the scheme which I have had before me in the course of these lectures. You all know the different systems which have been proposed for lighting. You know how arc lights have been distributed in series, and how incandescent lamps have been put on multiple arc in large stations. More especially you are acquainted with what has been done in America in this matter. In some cases only a special system has been thoroughly worked out, and in very few cases, I fancy, have different systems been relatively compared and pursued so as to bring out the most economical condition possible.

Besides these different systems I have spoken of—the series and multiple arc systems—you are aware that the latter, the multiple arc, is subdivided into a number of different ways of distributing. You have all heard people talking about the network system, the system with three mains, and also of lines of centres distribution. There are different modes of multiple arc system. And so also we have another one, which is called the multiple series system, which has been used to a certain extent, and very successfully used, but which has very radical defects in it, which have prevented its general adoption; at the same time, many distinguished engineers believe that in the future there may be a possibility of making this system efficacious and of removing the defects which are in the way. The objection to the ordinary multiple system, where all the lamps are connected to two massive mains, or to a number of wires which are so connected together as to make two massive mains, is the enormous cost of the conductors.

Besides the difficulty that the electric lighting act is simply unworkable, as every unprejudiced person must admit that it is, there is no doubt another fact which has largely hindered electric lighting, and that is the enormous cost of the mains. And not only that, but the multiple arc system introduces another serious expense. It becomes essential with such large mains to have our central station and our engines in the centre of the district which is being supplied. Now, in a thickly-populated neighborhood, such as it would be economical to light on the multiple arc system, it is very difficult to get a site for your engine and dynamos, and this has been acknowledged by those who have tried to undertake the system in London, to be one of the most serious objections to the multiple arc system. Thus at every point we see that it is of the utmost importance that engineers should devote their attention to economy in the construction of their mains to enable us to have a good supply after the most economical system of mains which is possible, whether that system be multiple arc or multiple series, or any other of the modifications which have been proposed.

1. Cantor Lecture delivered by Prof. George Forbes at the Society of Arts, February 2d, 1885.

The question of the production of electricity is one about which I need say very few words indeed. At the present time we produce our electricity by means of dynamo machines, by far the cheapest we have, and there is no immediate prospect of any other system being introduced which is more economical. Secondary batteries, being supplied with their power from dynamos, may be looked upon more as a system of supply than as a means of production of electricity; and the same may be said of secondary generators, which have attracted considerable attention in the last year or two.

COMPARISON OF GAS AND ELECTRICAL DISTRIBUTION.

Before proceeding directly to the problem of the supply and distribution of electricity, let us take a general survey and a comparison between electricity and gas in this respect. The production of gas is a far more complicated operation than the production of electricity; it is a somewhat complicated chemical laboratory experiment produced on a large manufacturing industrial scale. When we come to the supply of gas the problems resemble each other at first sight a good deal. The gas must be supplied in the pipes at a certain pressure, the size of the pipes must be regulated by the supply, the pressure must be maintained, the quantity flowing must be so regulated that it shall not vary to any great amount. In all these points we have an analogue in the case of electricity. I shall use the term "pressure" in these lectures because it is now introduced as a parliamentary term, and I do not see that it is not a correct scientific term to indicate the pressure at any point by indicating the difference of potential between the conductors at that point. We have to do the same thing with electricity as with gas; we must supply it in such a way that the pressure of electricity at different points shall not vary much. There are two points in which gas differs very materially from electricity. The one is that if you take a hundred wires of certain diameter and pass a current of electricity through them, and then pass a current through the same mass of copper grouped in one wire, the resistance offered in the two conductors is the same. If, however, in the case of gas, you pass the gas through a hundred small pipes and then through one large pipe of the same area, you have far more resistance in the hundred pipes than you have in the one. This is the reason why although we often see electrical cables made up in strands, in gas we see them in large pipes as required for the regular flow of gas. The other point of difference is in the cost of mains. The difference consists in this that with gas the pipes are hollow and it is simply the space which is filled with the illuminating material, gas, while in electricity the conductor is solid and the electricity passes through the solid material. The consequence of this is that whereas in gas the cost of mains is not in proportion to the quantity of gas which is to flow through those mains, in electricity it is certainly fully in proportion to the quantity, and that is why when we come to large electric mains we have such an expensive system to deal with.

While I am comparing with gas, allow me to say just one word about the introduction of electricity. It astonishes one to think for a moment how serious have been the difficulties in introducing electricity when really the obstacles to introducing gas were so much greater. When gas was introduced people knew nothing about a central supply of an illuminating agent, and knew nothing of the requisite size of pipes. It was a leap in the dark. The gases were objectionable, the burners infamous, smoke and sulphurous fumes were given off, and from the naked flame there was a constant danger of setting fire to houses; the gas vitiating the air, blackening surrounding objects, and the smell objectionable. Moreover it was impossible to prevent leaks, and leaks meant explosions. It was impossible to prevent ignorant people from blowing out gas or leaving cocks turned on, and in that way explosions and deaths from suffocation resulted. Electricity has none of

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these disadvantages. There has been great talk about risk from fire and risk from shocks. There is nothing of this, a properly laid line gives infinitely less danger, even with a high potential than that from explosions and fires by gas.

THE GENERAL PROBLEM OF ELECTRICAL DISTRIBUTION.

Now then let it be taken for granted that what the engineer has to do is to reduce the cost of his mains as greatly as it is possible. Our object then is to diminish this cost, and whenever we find that by diminishing the cost of our mains we are introducing a new engineering difficulty, then that is a problem for the engineer to overcome, and he must overcome it some way or other, if it possibly can be overcome, rather than increase the cost of his mains. Now there are three different reasons why it is objectionable to diminish the size of the mains too much: First, the great wasting in the energy which is used up by the resistance of those mains. We have to supply so much extra power in our central station in order to waste much simply by the heating of those mains, and that means an annual expenditure of a certain sum of money, whereas if we had made the mains a little thicker, we should not be wasting so much energy, and therefore in the primary outlay of a certain sum of money we should be saving an annual expenditure. The question is, of course, to balance these two matters in such a way that we arrive at the most economical result.

Now let us just look at the problem with a few figures before us to see on what scale we are dealing. Suppose that we are using a conductor of a square inch section to carry 1,000 ampères. The resistance of 100 yards of that conductor of pure copper would be ·0024 of an ohm. Now the energy which is used up is given you by the calculation $C^2 R$ divided by 746. That is equal to 3·2 h. p. used up in every hundred yards of our conductor for every thousand ampères. Now what is the cost of this electrical h. p. per annum? It is usually considered safe to say a h. p. costs £10 per annum, but owing to the period in which electricity would be used that is not a safe figure. Let me begin by considering £20 as the cost of h. p. £64 is the cost of the total h. p. We have wasted in four years in every hundred yards £256; in 20 years £1,280 is wasted in that conductor. Now, if I double the size of my conductor, I have the quantity of power wasting reduced to £640. The question comes to me, would it cost more than £640 of capital to lay down an extra hundred yards of a similar section? No, it would not, and therefore it is economical to double my conductor. And so we go on, step by step, until we find that the gain is just equal to the extra expenditure of capital in the laying down of conductors, and then we have

TABLE I.

B. W. G.	Diameter in Inches.	Section in square inches.	lbs. copper per 100 yards.	Resistance per 100 yards at 15·5° C., or 60° F.		Wire heated to 9° above temperature of air.		Wire heated to 25° above temperature of air.		Diameter in Inches.	B. W. G.
				B. A. Units.	Legal Ohms.	Current.	Loss in volts.	Current.	Loss in volts.		
							per 100 y'rds.		per 100 y'rds.		
	2·26	4·0	4608·	·000634	·000627	1514·	·998	2490·	1·730	2·26	
	2·11	3·5	4032·	·000724	·000716	1384·	1·042	2246·	1·783	2·11	
	1·95	3·0	3456·	·000845	·000835	1228·	1·079	1995·	1·847	1·95	
	1·78	2·5	2880·	·00101	·000999	1072·	1·125	1739·	1·931	1·78	
	1·60	2·0	2304·	·00127	·00126	913·	1·205	1482·	2·059	1·60	
	1·38	1·5	1728·	·00163	·00161	732·	1·288	1188·	2·187	1·38	
	1·13	1·0000	1152·	·00253	·00250	542·1	1·426	880·0	2·446	1·13	
	1·00	·7854	904·78	·00326	·00324	451·5	1·513	732·7	2·586	1·0	
	·75	·44178	508·93	·00584	·00578	293·0	1·746	475·5	2·991	·75	
	·707	·39250	452·16	·00653	·00651	268·0	1·800	435·2	3·081	·707	
	·500	·19635	226·18	·01307	·01292	159·4	2.139	258·6	3·659	·500	
0000	·454	·1618	186·39	·01567	·01550	138·1	2·248	224·1	3·854	·454	0000
000	·425	·1419	163·47	·01786	·01766	125·1	2·323	203·0	3·977	·425	000
00	·380	.1134	130·64	·02236	·02211	105·7	2·456	171·4	4·201	·380	00
	·354	·09842	113·37	·02605	·02576	95·1	2·546	154·3	4·357	·354	
0	·340	·09079	104·60	·02824	·02793	89·4	2·594	145·1	4·442	·340	0
1	·300	·07068	81·42	·03637	·03597	74·0	2·755	120·1	4·722	·300	
2	·284	·06334	73·00	·04048	·04003	68·63	2·850	111·4	4·880	·284	
3	·259	·05268	68·68	·04867	·04823	59·60	2·981	96·7	5·102	·259	
4	·238	·04448	51·61	·05764	·05700	52·37	3·102	85·0	5·315	·238	
5	·220	·03801	43·78	·06740	·06665	46·5	3·213	75·5	5·521	·220	
6	·203	·03236	37·27	·07937	·07849	41·27	3·360	66·97	5·762	·203	6
7	·180	·02544	29·3	·1006	·08943	34·31	3·553	55·69	6·084	·180	7
8	·165	·02138	24·62	·1199	·11857	30·25	3·728	49·09	6·384	·165	8
9	·148	·01720	19·81	·1492	·14643	25·28	3·878	41·03	6·630	·148	9
10	·134	·014102	16·25	·1812	·17919	22·12	4·133	35·90	7·075	·134	10
11	·120	·011309	13·00	·2267	·22418	18·74	4·366	30·41	7·473	·120	11
12	·109	·009331	10·74	·2748	·27175	16·25	4·589	26·38	7·857	·109	12
13	·095	·007088	8·16	·3617	·35769	13·09	4·866	21·25	8·332	·095	13
14	·083	·005410	6·23	·4739	·47064	10·84	5·280	17·58	9·031	·083	14
15	·072	·004071	4·68	·6298	·62281	8723	5·646	14·14	9·652	·072	15
16	·065	·003318	3·82	·7727	·76412	7·481	5·931	12·14	10·169	·065	16
17	·058	·002642	3·04	·9711	·96032	6·371	6·354	10·24	10·771	·058	17
18	·049	·001885	2·07	1·3598	1·3447	4·876	6·813	7·95	11·691	·049	18
19	·042	·0013854	1·60	1·8502	1·8297	3·883	7·485	6·31	12·658	·042	19
20	·035	·0009621	1·108	2·6650	2·6354	2·953	8·087	4·80	13·866	·035	20

Legal volts, 96 per cent. conductivity; copper-heating of bare copper wire, emissivity = ·00025 C. G. S units.

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arrived at a satisfactory arrangement. You will easily see if you work this out. Now this is an important point, in fact one of primary importance. It was first approached by Sir William Thomson in an address to the British Association in 1881, in which he read a paper on "The Economy of Metal Conductors of Electricity," and in a most interesting paper he arrived at the conclusion that the interest on the capital spent upon the conductors should be equal to the value of the energy which is wasted annually in these conductors.

COST OF AN ELECTRICAL HORSE POWER.

The first question which becomes a trouble is, what are we to consider the cost of electrical h. p.? There are two ways of looking at this problem, and we will just glance at them independently. First, let us take the case of an installation which has been thoroughly carefully estimated for, and let us see there, after the whole of the buildings, distributing and supply plant, and everything has been laid down, what is the cost of each h. p. of electricity, if you like to call it so. To give you a perfectly unbiased example, I have taken the figures, kindly furnished by Mr. Crompton, of a large installation which he carefully prepared estimates for. I find, on looking into this, that in this case the cost of electrical h. p.—of course, depending on the number of hours used during the year—if it was for 1,000 hours, the cost of h. p. came to about 5d.; for 2,000 hours in the year, 3·5d.; and for 3,000 hours only 3d.; and that means, for the year in these three cases it would be 5,000 pence, 7,000 pence, and 9,000 pence. Now the next question that comes before us is, what is the number of hours we are supposed to use our electricity? There is very little doubt that about 1,000 hours is probably a fair average consumption of people in a town; but I think it very likely that, at any rate, in the first installation set up a certain selection will be possible, which will raise the average a little higher. For my own purposes at present, I am going to assume 1,500 hours; if you prefer another value you can work it out yourself to suit it. That will be the average cost of those two, which comes almost exactly to £25 a year. Now if you work out the cost of the energy wasted in a 1,000 yards conductor, you will find, I think, that the following figures are energy wasted in the conductor for 3½ inches, 4 inches, 4½ inches, 5 inches, 5½ inches, 6 inches, and 6½ inches; the amount is £22·8, £20, £17·8, £16, £14·5, £13·2, and £12. Therefore, the gain in passing from this to this is 2·8, 2·2, 1·8, 1·5, 1·3, and 1·2. These are the gains which there are in increasing the size of the conductor. Up to this point it is all plain sailing, a matter of plain calculation. The next thing is, what is the interest on the capital which is expended? This, of course, depends on the way in which the mains are laid, and different people have different ideas about how they should be laid. Many people lay mains at present with stranded cables. For my own part, I cannot see what is the object of doing this; it is the most expensive form in which you can produce your copper, and really nothing is to be gained. It seems to me simply to arise from the fact that cables we used previously were submarine cables, and certainly they are of great advantage there; but why they should be used on land, where there is no strain, I see no earthly reason. Others think they should be laid in massive bars of semi-circular shape, covered with bituminous compound; others that in flat sheets laid in troughs. At any rate, every person differs from every other, and consequently every person must have a different value for his cost of copper. But I have taken it as an example, simply, and you need not take the value I use. Take the £100 a ton as the cost of adding an additional amount of copper to our mains, after the troughs and so on have been laid. In that case the interest upon it depends upon the percentage which we allow. Now, what are we to allow? Ought it to be 5, 7½, or 10? That, again, is a question for the engineer to determine for himself. But allow me to

TABLE IIa.—SECTION PER THOUSAND AMPERES IN INCHES.

Annual Cost of Electrical H. P. £	1	1·1	1·2	1·3	1·4	1.5	1·6	1·7	1·8	1·9	2	2.1	2·2	2·3	2·4	2·5	2·6	£
5	1·628	1·356	1·147	·980	·857	·746	·658	·585	·523	·471	·426	·386	·355	·324	298	·276	·255	5
6	1·954	1·627	1·377	1·176	1·028	·895	·790	·702	·628	·565	·511	·463	·426	·389	·358	·331	·305	6
7	2·279	1·898	1·606	1·372	1·199	1·044	·921	·819	·733	·660	·596	·540	·498	·454	·417	·386	·356	7
8	2·605	2·169	1·836	1·568	1·370	1·194	1·053	·936	·838	·754	682	·618	·569	·518	·477	·442	·407	8
9	2·930	2·441	2·065	1·764	1·542	1·343	1.185	1·053	·942	·848	·767	·695	·640	·583	·536	·497	·458	9
10	3·256	2·712	2·295	1·960	1·713	1·492	1·316	1·170	1·047	·942	·852	·772	·711	·648	·596	·552	·509	10
11		2·983	2·524	2·156	1·885	1·641	1·448	1·287	1·152	1·037	·937	·849	·782	·712	·656	·607	·560	11
12			2·754	2·352	2·056	1·790	1·580	1·404	1·256	1·131	1·022	·926	·853	·778	·715	·662	·611	12
13				2·548	2·227	1·940	1·711	1·521	1·361	1·225	1·108	1·004	·924	·842	·775	·718	·662	13
14					2·398	2·089	1·843	1·638	1·466	1·319	1·193	1·081	·995	·907	·834	·773	·713	14
15						2·238	1·975	1·755	1·570	1·414	1·278	1·158	1·066	·972	·894	·828	·764	15
16							2·106	1·872	1·675	1·508	1·363	1·235	1·137	1·037	·954	·883	·814	16
17								1·990	1·780	1·602	1·448	1·312	1·208	1·102	1·013	·938	·865	17
18									1·884	1·696	1·584	1·390	1·279	1·166	1.073	·994	·916	18
19										1·790	1·619	1·467	1·351	1.231	1·132	1·049	·967	19
20											1·704	1·544	1·413	1 296	1·192	1·104	1·018	20

Annual Cost of Electrical H. P. £	2·7	2·8	2·9	3·0	3·1	3·2	3·3	3·4	3·5	3·6	3·7	3·8	3·9	4	4·5	5·0	5·5	6·0	£
5	·237	·221	·206	·192	·180	·170	·160	·150											5
6	·284	·265	·247	·230	·216	·203	·192	·180	·170										6
7	·331	·309	·288	·269	·252	·237	·224	·210	·199	·108									7
8	·378	·353	·329	·307	·288	·271	·256	·240	·227	·215	·203								8
9	·426	·397	·370	·346	·324	·305	·288	·270	·256	·242	·229	·217							9
10	·473	·441	·411	·384	·360	·339	·320	·300	·284	·269	·254	·241	·220						10
11	·520	·485	·452	·422	·396	·373	·352	·330	·312	·296	·279	·265	·252	·240					11
12	·568	·529	·493	·461	·432	·407	·384	·360	·341	·323	·305	·289	·275	·262	·206				12
13	·615	·573	·534	·499	·468	·440	·416	·390	·369	·350	·330	·313	·298	·283	·224	·181			13
14	·662	·617	·575	·538	·504	·475	·448	·420	·398	·379	·356	·337	·321	·305	·241	·195	·162		14
15	·710	·662	·617	·576	·540	·509	·480	·450	·426	·404	·381	·362	·344	·327	·258	·209	·174	·147	15
16	·757	·706	·658	·614	·576	·542	·512	·480	·454	·430	·406	·386	·366	·349	·275	.223	·186	·156	16
17	·804	·750	·699	·653	·612	·576	·544	·510	·483	·457	·432	·410	·389	·371	·292	·237	·199	·166	17
18	·851	·794	·740	·691	·648	·610	·576	·540	·511	·484	·457	·434	·412	·392	·310	·251	·209	·176	18
19	·899	·838	·781	·730	·684	·644	·608	·570	·540	·511	·483	·458	·435	·414	·327	·265	·220	·186	19
20	·946	·882	·822	·768	·720	·678	·640	·600	·568	·538	·508	·482	·458	·436	·344	·279	·232	·196	20

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point this out, when we are increasing the size of our mains, really we ought to be diminishing the percentage allowed for maintenance. The wear and tear is less, heating is less, the danger to insulation is less, everything leads us to believe there is a less cost of maintenance with a large conductor than with a small. This is a very important point. Each one must judge for himself whether to take 5, 7½, or 10. He will find with 5 per cent. the annual cost is 1·27, at 7½ per cent. 1·91, at 10 per cent. 2·55; so that what we have to do is to find that size of conductor which should equal the interest which we happen to consider the right interest. Supposing 5 per cent., then we have 1·27 settled, which gives 6 inches; 7½ per cent. 1·91, about 4 or 4½ inches; and 10 per cent. 2·55; between 3·5 and 4 inches for a 1,000 ampères. I have gone through this example carefully, just to give you a clear conception of the way in which the problem is to be worked out, but I think you may very safely say that the consumption I have taken is too large. It is perfectly true that in this estimate to which I have alluded is included the cost of buildings, engines, dynamos, boilers, and other machinery, the mains, and also includes the annual cost of coals at 18s. per ton. Well, all these points to come in, therefore it is a question for each one to consider for himself how far these things are to be divided in this way. It may be said by some, however, that it is desirable only to look upon our plant as being fixed, and supposing we want to carry extra current on the same size of conductor, would it be wise to do so or not?

I may now draw your attention to a table which I have drawn out for these lectures, which I have found of great use already, and which I believe all electrical engineers will find of use, too.

THE ENGINEERING PROBLEM.

The engineer can choose his facts for himself absolutely, can choose what he considers to be the right value of the electrical h. p. every year for the number of hours he proposes to run. He can also choose the cost of copper which he thinks it will suit him to lay. Having done that he proceeds in this manner: I will take as an example copper costing £100 a ton; take 7½ as the rate of interest; I look along the column of table II*b*. until I find £100, look down until I come to 7½ and find the figure ·386. I then look to the top of the table II*a*. and I have £8 a year, say, for my electrical h. p. I look along the column of £8 a year until I find the figure nearest to ·386 and I find that it comes to a place beneath the number 2·7; in that case 2·7 would be the square inches which are required for the main on those conditions imposed by the engineer himself. I have given another table for continual reference, giving the resistance of 100 yards and various other facts, also the current which will heat the wire.

Before leaving the subject of the cost allow me to once more impress upon you that I consider this matter of primary importance and no considerations must ever lead the engineer to deviate from the strict rules which regulate the cost. It may be in some special cases not always practicable to regulate our wires to carry the current exactly at this rate. It may be because it is easy to get a stock of conductor of a slightly different size, or it may be inconvenient to be always varying the estimate in the size. But these principles must be gone into for every part of the scheme, and in our practical application we must stick as closely to our results arrived at there as we possibly can. It is no use for the engineer to say financial people will not bring forward the money for these costly mains. The engineer, in my way of looking at it, has no right to look at what the financier wants to do. He must tell them honestly what is the most economical thing to do. If the financier wants to lay out capital in a particular direction knowing that he will be causing a waste of energy, the engineer ought to have nothing to do with such matters. He ought honestly to give the value of the current which is most economical.

I have dealt now fully enough with the first cost that prevents us from diminishing the thickness of our conductors. The second cause why we should not reduce too much is the heating of the conductors. There are in this three injurious facts—in the first place it spoils the insulation; the insulating power of the material diminishes by being heated, and the material itself becomes injured; moreover, when it is hot it usually becomes soft and the conductors can sink into it and so become decentralized. And in the second place the conductors themselves are injured, because their resistance is increased by the increase of temperature, and these increases of temperature, mark you, are very considerable. And in the third place the increase of temperature may be very serious, and may actually be objectionable along the streets. I have here a small piece of cable which shows the decentralizing action of bituminous compound. This has been lying for six or eight months in a cool part of a cool room, always lying in the same position. I believe when I got it it was perfect, but in a cool place it gradually sunk, and now it is very decidedly out of centre. An old experiment which I used to show when I held my chair at Glasgow illustrates the viscosity of objects. It was first suggested to me and I first saw it done by Sir William Thomson in his laboratory. By taking hard, brittle pitch—or shoemaker's wax would serve the same purpose—take a block of it, put a bullet on the top and corks underneath; in six months the bullet will have sunk into the block and the corks will have risen several inches up through it. This simply shows you how such bituminous compounds must be carefully watched, and how very objectionable is any viscous material in the way of decentralizing the conductor.

DEVELOPMENT OF HEAT IN CONDUCTORS.

Now as to the question of heating conductors, I will not take up much of your time this evening, because I have already in a lecture which I gave at the Society of Telegraph Engineers last year, gone into the question very fully.

TABLE II*b*.

Percentage allowed for interest and depreciation per annum.	COST OF LAYING ONE ADDITIONAL TON OF COPPER.																					Percentage allowed for interest and depreciation per annum.
	£60	£65	£70	£75	£80	£85	£90	£95	£100	£110	£120	£130	£140	£150	£200	£250	£300	£350	£400	£450	£500	
5	.154	·167	·180	·193	·206	·219	·231	·244	·257	·283	·309	·334	·360	·385	·514	·643	·772	·900	1·029	1·157	1·286	5
7½	·231	·251	·270	·289	·309	·328	·347	·366	·386	·424	·463	·501	·540	·579	·771	·964	1·157	1·350	1·543	1·736	1·929	7½
10	·308	·334	·360	·386	·411	·437	·462	·488	·514	·565	·617	·668	·720	·770	1·029	1·286	1·543	1·800	2·057	2·315	2·571	10
12½	·385	·418	·450	·482	·515	·546	·578	·610	·643	·707	·772	·835	·900	·964	1·285	1·607	1·929	2.250	2·572	2·893	3·205	12½
15	·463	.501	·540	·578	·617	·656	·694	·733	·771	·849	·926	1·003	1·080	1·155	1·543	1·928	2·314	2·700	3·086	3·471	3·857	15
20	·616	·668	·720	·771	·824	·875	·925	·976	1·029	1·131	1·235	1·336	1·440	1·540	2·056	2·571	3·089	3·600	4·115	4·629	5·144	20
25	·771	·835	·900	·964	1·028	1·093	1·156	1·221	1·285	1·415	1·543	1·671	1·800	1·925	2·572	3·125	3·857	4·500	5·143	5·786	6·430	25

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I only draw your attention to the question now because there is an important point which I am glad to say needs correction. A discovery has been made of an error near the end of the paper which might be misleading, and which probably has misled some. I will give you a corrected edition of it.

Here is the table to which I have referred. It gives you underground conductors. I have recommended sheets of copper for underground conductors, because the temperature is far less raised when you have a thin conductor.

Width in inches of copper conductor 1 cmr. thick.	Cross section in square inches.	Current to raise surface temperature 10° C. ampères.
3·2	0·25	250
12·7	0·98	1,000
38·1	2·95	3,000
63·5	4·92	5,000
127·0	9·84	10,000
889·1	68·88	70,000

This is a most important point. We have absolute control over the temperature; by widening out our sheet we have diminished temperature, and can make the heat of conductors subservient to economy.

I pointed out that if you do not bury your conductors more than about two feet the surface temperature is not affected; only the temperature of the conductor. If you go two feet deeper you will affect the surface temperature also. I have thought that up to 10° centigrade is the limit endurable by foot passengers. In the summer the rising temperature of the pavement is most objectionable; fortunately this is the time when the current is least used. Moreover the temperature does not immediately pass through the ground. The daily variations of surface temperature differs as the diurnal change of position of the sun: it does not penetrate very deep down—is very slightly perceptible at two feet depth. And if we have 500 ampères flowing for 24 hours, the effect would be almost exactly the same as if 1,000 ampères were flowing for six hours. Another point, if instead of laying a sheet one centimetre thick, you might lay cables with the same result provided the average thickness was one centimetre.

PROPER SIZE OF CONDUCTORS.

In speaking of the economical size of conductors, I arrived at the conclusion that I must use 2·7 inches, or say 3 inches for 1,000 ampères; but mark you, though 1,000 amperes is the average current, it is not the maximum current to pass through that conductor. The maximum is a very different thing indeed to that. When we have an average of 1,000 ampères it does not in the least mean that that is the average quantity of current which is flowing through it, because the wasted energy depends upon the square of the current. This leads to a very different law, and a very important one, about which I have a word or two to say. Suppose n_1 is the number of hours during which a quarter of the lamps are burning, n_2 one-half, n_3 three-quarters, and n_4 the number of hours during which all the lamps are burning.

Then the average quantity can be got from the maximum quantity by multiplying all these fractions. If half the lamps are burning two-thirds of the time and the rest of the time all the lamps are burning, we get a equal to ·5. Therefore, instead of having 2·7 we only have 1·35 as the sectional area for 1,000 ampères. As a matter of fact I shall select for the rest of the lectures the quantity 1·5 square inches to the maximum current of 1,000 ampères. It seems to me for a working hypothesis, which no one need adopt, a good enough value.

The third reason why we cannot reduce the size of the conductors too much is that the potential falls, and the thinner the conductor the greater the fall of potential between the dynamo and the lamps. With a large current there is a great fall of potential (experiment shown), thus showing that in a central lighting station the fall of pressure, and therefore the brightening of the lamps in the district, depends upon the number of lamps in use at the time.

Ratio of $\frac{\textit{average}}{\textit{maximum}}$ *current.*

n_1	n_2	n_3	n_4	a
0	0	0	1	1·000
0	1	0	1	0·790
1	2	2	1	0·744
1	1	1	1	0·685
2	2	1	1	0·604
0	2	0	1	0·500

This is a serious thing, and the most difficult engineering problem with which we have to deal. We have arrived at the consideration that a square inch and a half for 1,000 ampères is the size we must use, that means a fall of potential of 1·6 volts for each conductor in every 100 yards, that is to say, a fall of nearly 3¼ volts with the double conductor for a distance of 100 yards, and whether you like it or not you must have it. It may be met by making distant consumers use lamps requiring a different pressure to those nearer. This is the thing which has given most trouble, and the point will be considered in the next lectures.

SYSTEMS OF LAYING CONDUCTORS.

I had hoped to have gone a little into a description of systems of laying mains which have been already adopted, but time is pressing too much. I will just say a few words about some of the systems I saw at the Philadelphia exhibition last year. People seemed to have missed altogether the point that is to be aimed at in underground conductors. There was a list of inventions shown, simply consisting of tiles with holes through them, the cables to go through the holes. For low potential work it is not such a very difficult thing, and there has been a fair trial.

EDISON'S CONDUCTORS.

Outside in inches.	Area of one conductor in circular mils.	Maximum current in ampères.
3·5	1,639,890	1,400
3·0	862,976	760
2·25	262,951	370
1·31	107,289	220
1·05	33,000	100

These are laid in bituminous compounds in iron pipes, and seem to work pretty well for low potential work, but every electrical engineer thinks we shall be able to introduce high potentials some time or other, and reduce the cost of these mains.

DIFFICULTY OF INSULATION.

What is it that makes it so difficult to insulate these mains properly? It is very difficult to say. It may be that there is a faint leak, and a spark passes to the iron pipe in which the conductors are encased and that gives rise to an increasing leak. It may be that where there is the faintest leakage there is a partial decomposition of the water that comes into contact with it and that brings electrolytic action into contact with the insulating material, which we know it generally destroys and so the leak becomes worse and very bad indeed. Through the kindness of the Brush company I have here a specimen of a fault in one of their underground city conductors showing where it is eaten into. In Philadelphia there were some systems shown in which there was a very wide trough and glass

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plates introduced here and there, in which was a large number of holes. Glass is a very bad substance to use; it gets such a moisture upon it that I should not have thought it was the best thing to use, and beside there is a tremendous wasting of space for small wire. In another, copper rods were carried through pipes made as water-tight as possible, supported on rings of glazed porcelain so that there is a very small surface of leakage possible. With the rings here and there of course dampness was a serious obstacle; and in this system it was proposed to blow dry air through the pipes so as to keep the moisture continually out of them. I can only say of this that it is only a proposition, the thing has never been done.

UNDERGROUND CONDUCTORS.

I had hoped to speak to you of what has been done in underground conductors, but really there is very little to tell you and that can be said in very few words. In Philadelphia there was a system of underground conductors put down by the Excelsior company, and they worked pretty well. They used large troughs and where there are large troughs there is no difficulty about it. But these large troughs had very serious inconveniences that one hardly expected from electricity. Three times during the time I was at Philadelphia the troughs in Chestnut street blew up, a most unexpected result from an electric conductor, but it was a positive fact, and the secret was they were too near the gas mains, which leaked and positively filled the troughs and consequently they blew up. However, these were accidents that might have been prevented with care.

I have an illustration here of the installation at Colchester, which illustrates the way in which very large troughs are laid with conductors cut along them.

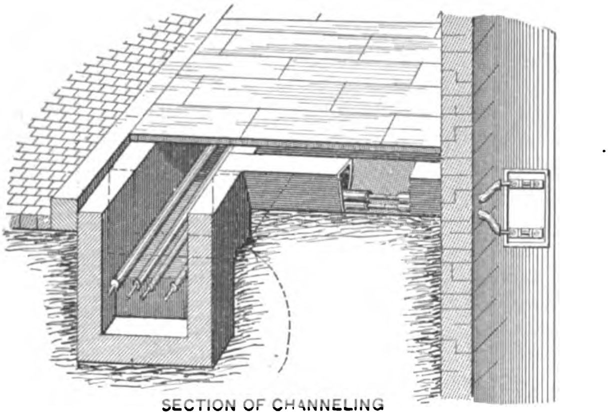

FIGURE 1.—CHANNELLING SHOWING CHARGING AND SUPPLY CABLES.

The Jablochkoff company on the Thames Embankment has had a lengthened experience extending since 1878, with a small $\frac{7}{16}$ strand wire covered with gutta-percha and tape and put in troughs underground, where it has given very little trouble. Then, again, in the city the Brush company has had these conductors underground since April, 1880, and they have had a great deal of trouble. They tell me that they were put in first very loosely and covered with sand for some reason or other, and in drawing the cables through the pipes the sand wore them away and the consequence was the insulation went.

Here is a curve showing the insulation resistance of these cables extending over a lengthened period. The variations of the curve indicate continual cases of faults being discovered. This is a very instructive curve, and shows the difficulties of working with conductors simply laid in the ground in that way. I have no doubt that other people have had large experience with high potential conductors, and I wish I could have succeeded in getting a larger number of facts to put before you, but unfortunately I have not come across them. This lecture is simply preparing the way for the consideration of different systems of laying conductors. In succeeding lectures we

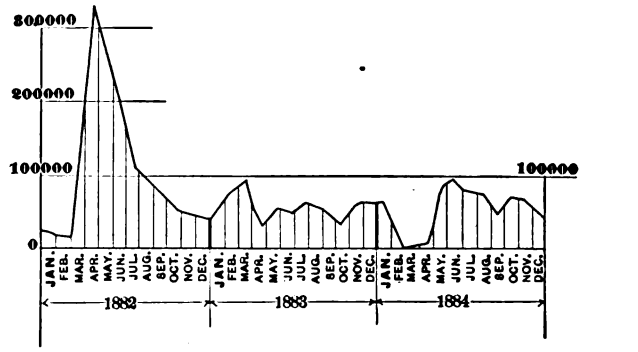

FIGURE 2.—INSULATION RESISTANCE OF UNDERGROUND CABLES.

shall see how engineers have attempted to get over the problem of fall of potential, and how to combine economy with efficient working.

ATMOSPHERIC ELECTRICITY.[1]

BY LUCIEN I. BLAKE, PH. D.

SINCE the earliest times, the electrical phenomena of the atmosphere have been a cause of wonder and fear. The manifestations, on the one hand, of prodigious power in the lightning and thunder, or on the other, of a subtle force, in the mysterious manner life is destroyed, or objects instantly rent into pieces, have naturally led thoughtful minds, in all ages, to seek an origin for this atmospheric electricity However, up to the time of Volta in 1782, no theories had taken definite expression. The gods of the Greeks and Romans rumbling around in the air above, or probing now and then the ribs of mother earth with fire bolts, did not long satisfy common sense.

Volta found by experiment, with what now would be a crude electroscope, that an evaporating liquid produced electricity. He therefore saw in the immense evaporation from the ocean going on in the tropics a sufficient cause to continually stock with electricity the vapor currents pouring off toward the poles. Upon condensation of these vapors then, as they strike cooler currents, their electricity became apparent in lightning, etc. The moisture itself as *vapor* was a non-conductor, and consequently each vapor particle contained merely the amount of electricity first given it at evaporation. On condensation, however, the electricity would spread to the surfaces of the conducting cloud masses, and with sufficient increase of electrical density manifest itself in lightning and thunder phenomena. This theory seemed so plausible that, being corroborated by Volta's experiments, it was quite generally accepted. Forty-five years afterward, in 1827, Pouillet,[3] with better apparatus, repeated Volta's experiments and obtained similar results—that evaporation did produce electricity. Further, in our own day, Tait and Wanklyn[4] likewise assert a production of electricity in their experiments on evaporation.

However, there were other experimenters of authority who asserted exactly the opposite,—that *no* electricity was produced by evaporation. Saussure,[5] in his "Voyages dans des Alpes," 1786; Erman[6] in Germany in 1818; Gaugain[7]

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1. Read before the New York Electrical Society, July, 1884, and awarded the prize of $20, offered by Mr. F. W. Jones, for the best electrical essay prepared by any member and presented for competition, in compliance with certain stipulations.
2. *Volta.* Phil. Trans., 15, p. 274. 1782.
3. Pouillet, Ann. de Chim. et de Phys., 35, p. 401. 1827.
4. Tait and Wanklyn, Phil. Mag., 4, 23, p. 494. 1862. Nature, 23, p. 330.
5. Saussure, Voyages dans des Alpes, 2, p. 227 and 229. 1786.
6. Erman, Abh der Berl. Akad, 19, p. 25, 1818.
7. Gaugain, Comptes Rendus, 38. p. 1012. 1854.

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in France in 1854, and Riess[8] in Germany in 1853, each with better apparatus than either Volta or Pouillet had, failed to detect a production of electricity by simple evaporation. Riess, moreover, showed that in Volta's and Pouillet's experiments, the electricity obtained was due to *friction*—especially when the liquid was in the spheroidal state, as in most of their experiments. The results of Riess are now generally accepted, and *evaporation from the ocean's surface* discarded as a sufficient cause of the great quantities of electricity in our atmosphere.

A *second* hypothesis has been widely accepted in both former and our own times. Benjamin Franklin[9] was among the first to propose it. Becquerel[10] and De la Rive[11] in France, advocated it, and it is adhered to by some of the greatest modern scientists. The surface of the ocean is known by experiment to be electrified. The vapors arising from it, especially in the tropics, carry with them its electricity into the atmosphere, and then in their condensation the electricity again becomes apparent. This theory is so simple, and since it has been always stated *as a law*, and never questioned, that vapor arising from an electrified surface carries the electricity away with it, the theory is being more and more widely adopted as an explanation of the cause of atmospheric electricity. Sir William Thomson has been also numbered among its adherents. The whole theory evidently rests upon the law mentioned above, and which is stated in the text-books as the law of the convection of electricity by vapor from an electrified surface. This so-called law I shall show, from a course of experiments which I had the opportunity of carrying out a year ago, is false. *No* electricity is conveyed by vapor arising from a surface, however strongly electrified that surface may be. The experiments, the results of which were brought by Helmholtz before the Royal Academy, were conducted in brief as follows :—

In the *first series* of experiments, two brass discs, about five inches in diameter, were brought, so that their faces were separated about $\frac{1}{25}$ inch (1 mm.) from each other. These discs were very carefully insulated, and one of them was connected with one pole of a zinc-water-copper battery of 500 elements. The other pole of the battery was to ground. The disc became thus statically electrified to about 400 Daniells. On the electrified disc a layer of water was placed by condensation, and then the disc was gently warmed on the backside by a flame. The flame was then removed, for a flame always produces disturbing electrical effects. The other insulated colder disc was now brought up opposite it (1 mm.) as mentioned above, and the vapor of course, passed across from the moist warmer electrified disc and condensed upon the colder unelectrified disc. This latter disc was connected with a Helmholtz quadrant electrometer which was so sensitive that one Daniell cell gave a deflection of its needle of 70 mm. scale divisions, when the scale was about 15 ft. from the mirror of the needle. This electrometer differs from the Thomson quadrant electrometer principally in charging the *quadrants* permanently, and putting the electricity to be tested upon the needle, exactly the reverse of Thomson. Under the above conditions of experiment, the electrometer gave not the slightest indication of electricity upon the colder disc, notwithstanding the vapor which had just left the highly electrified surface condensed in heavy drops upon it. The electrometer was capable, as stated, of indicating $\frac{1}{140}$ of a Daniell, and here the electrified disc, from which the vapor came, had a potential of 56,000 times that amount, and not a trace of electricity was revealed as coming with the vapor.

The second series of experiments was to allow evaporation from *different* liquids. Among these were salt solutions, alcohol, sulphuric acid, and *ocean water*. They were put, in turn, into a shallow porcelain dish which was insulated, and connected with one pole of the battery mentioned above, whose other pole was to ground. Then this liquid was gently heated, until rapid evaporation took place, and the flame was removed. Over the liquid was suspended a cold brass disc, which was insulated and connected with the electrometer. The vapors now condensed in large drops on the disc, but the electrometer indicated not a trace of electricity, coming with them. To make the potential of the liquid still higher, I electrified it by a Töpler-Holtz machine, which I ran with great regularity by a little water-motor. Sparks would now pass from the surface of the liquid to the disc suspended over it. Then the disc was moved just far enough from the surface of the liquid so that the sparks could no longer pass—*i. e.*, just the slightest degree farther than the so called "striking distance," and of course then the electrification of the liquid was at its maximum. But even under these severe conditions not a trace of electricity went over with the vapor, which one could see rapidly condensing.

Finally, to make it still more general, mercury was used for the liquid. [The apparatus had to be somewhat altered of course.] According to the latest chemical theories a molecule of mercury contains only one atom of mercury, unlike all other gases which contain at least two. In the evaporation of mercury then we would have *atoms* arising from the electrified surface of the mercury and passing to condense into drops upon a platinum disc opposite. But here as in the preceding not a trace of electricity manifested itself upon the unelectrified disc. From such experiments there is but one conclusion, that the universally accepted law of the convection of electricity by vapors from an electrified surface is untrue. Any *theory* then, which would explain by it the cause of our atmospheric electricity must of course be given up. The question remains *still unsolved*, whence comes the great quantity of electricity constantly present in our atmosphere, and yet a first step to its solution is taken when we clear away existing theories which are defective, and thereby reopen the field for new researches.

The French Academy, to stimulate investigation in this line, offers a prize of 5,000 francs for the correct solution, before Jan. 1887. But to anyone there should be a greater incentive in the meteorological value of an accurate knowledge of the source or sources, and laws of action of atmospheric electricity.

Experiments already show that the electrical disturbances in the air are closely connected with and generally precede changes of weather.

Our government learning of this, has this last winter established two stations respectively at Harvard College and Johns Hopkins University in Baltimore, where electrical indications of the atmosphere are automatically registered. A change from positive to negative electrification generally precedes stormy weather, and so marked an indication, if proven as a general law, *may* become an important factor to our signal service bureau. At least when observations are taken simultaneously over large areas, laws *may* be discovered, which, combining with present meteorological methods will enable weather to be foretold with much increased accuracy and corresponding value to our commercial interests. This fact it is which should lend an impulse to research into the phenomena and cause or causes of our atmospheric electricity, and which, I think, justifies me in not considering this branch of experiment foreign to the aims of our Electrical Society of New York.

After the reading of the above, the President, Dr. Van der Weyde, made the following remarks:

Admitting that the existing theories upon the origin of atmospheric electricity are not fully satisfactory to explain all the details of the phenomena exhibited, we must, in order to be just, present these theories fairly and fully and not incompletely. In the paper just read, only one part has been stated, and the most important part omitted, as will be clear when I have explained the whole of the theory. Peltier a French physicist some forty years ago

8. Riess, Reibung's Electrizitat, 2, p. 407. 1853.
9. Franklin, Duprez, Neim. Cour. de l'Acad. de Belg., 16. 1848.
10. Becquerel, Traité de l'Elect., 4, p. 116. 1836.
11. De la Rive, Traité de l'Electricité, 3, p. 190. 1858.

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demonstrated that not only the surface of the ocean, as stated in the paper, but also the land, in fact the whole terrestrial surface possessed normally a charge of negative electricity, and that this charge is stronger in elevated portions than in valleys, according to the well-known law of static electricity which in a charged sphere will accumulate on the projecting parts. If a cloud comes in contact with the earth and forms what we call mist, it will become charged, and this charge will for the same reason accumulate on its upper surface, the electricity ascending as far as the conductivity of the cloud extends, while on the earth's surface no electricity will be perceptible; conformably to the law, that beneath the surface of an electrified body no electric charge will be perceptible; this fact is often illustrated by a variety of lecture-room experiments.

If now such a cloud or mist ascends, and becomes separated from the earth by a layer of non-conductive air, it will carry its negative charge to the upper regions, and this is one of the ways in which the atmosphere may become electrified. There is, however, another much more important and active operation going on, which is decidedly the most prolific source of atmospheric electricity; viz., static induction by an electrified terrestrial surface upon conducting clouds separated from it by a layer of non-conducting air; this great factor in the development of atmospheric electricity is entirely overlooked in the paper.

The law of static induction is well established and demonstrated by experiment. It is as follows: Any electrified body exerts upon a conductor within the sphere of its influence a peculiar action; this consists in disturbing the neutral condition, and causing a separation of the two inherent and mutually neutralizing electricities, in such a way that the electricity of the same kind as that in the electrified body will be repelled, and that of the opposite kind attracted, resulting in an electrified condition of the neutral body, which will manifest opposite electricities at its two extremities. In fact it is an extension of the law that opposite electricities attract one another, while those of the same name exert a mutual repulsive action. If we now apply this to the earth and the clouds, it is evident that a negatively charged terrestrial surface must make the under surface of the clouds positively electric, and their upper surface negative. Such a cloud layer may act upon other higher layers, and induce other charges, in fact we may have the experiment of the so-called cascade of Leyden jars or condensers on a gigantic scale; winds may now separate the positively charged portions from those charged negatively, and we obtain a variety of electrified clouds, which will exert their attractive and repulsive actions among themselves, and even also exert in their turn inductive action upon the earth, so that negatively charged clouds may induce that part of the earth over which they float to become positive. If we look at all this, we need not wonder at the immense amount of electricity manifested during thunder-storms, especially when we consider that an electrophorus will permit us to draw an unlimited number of sparks from its plate, and all this by inductive action—without losing its own charge. In a certain sense the earth acts like a gigantic electrophorus.

This theory, with which by a peculiar circumstance I became acquainted a short time after its first conception by the younger Peltier, I have always considered entirely adequate to explain the phenomena of atmospheric electricity, and it has commenced to be so considered by all authors of text-books who write them otherwise than by compiling older ones. The problem may at present be considered as reduced to these questions: How does our earth obtain its negative charge? Is it naturally provided with a charge which cannot escape across the interplanetary space? (We have now strong reasons to suppose this space to be an absolute non-conductor of electricity.) Is the electric charge continually developed by active volcanoes, vegetation or evaporation? The latter is very likely, and the experiments mentioned in the paper read, were originally intended by Pouillet, Matteucci, Helmholtz, and others, not to prove whether watery vapors conduct electricity, but whether evaporation will develop electricity in such a way that the ascending vapors will be positive, and leave the insulated receptacle from which the water is evaporated negative. Watery vapor may or may not conduct electricity, according to the dew-point; and this depends on three factors: temperature, amount and tension of vapor, and atmospheric pressure. When heated above the dew-point, watery vapor is a non-conductor, when below, it is a good conductor; witness the clouds, which are excellent conductors. This is the reason of the discrepancies in the results obtained by different experimenters, some of whom when they wished to test the development of electricity by evaporation, lost the electricity developed by conductivity through the vapor itself, or when they wished to demonstrate that vapor will conduct electricity, evolved a vapor at a temperature above the dew-point. If by artificial heat we wish to develop vapor which will conduct electricity, the temperature should not be too high; the air of the room should be moist, and the barometer low; if on the contrary we wish to obtain vapor which will not conduct electricity, we must make our experiment in a dry season and locality, with sufficiently high temperature and barometer. Such were the circumstances by which Pouillet and Matteucci obtained decided indications of the development of electricity by simple evaporation, Pouillet from salt water, and Matteucci from moist earth; to this we may add Volta, Laplace and Lavoisier who found that when water was dropped into a hot platinum crucible, electricity was evolved. Against positive results thus obtained, the failure of others who did not succeed amount to nothing, as negative proofs are no proofs whatsoever. Any person having had some experience in physical research, especially with electricity, knows how diversified may be the causes of failures in obtaining the results expected, and how often experiments fail, except when we are able to detect the causes of failure, and to have them corrected at once. One single successful experiment of this nature is a more convincing proof than a hundred failures.

TESTS OF WOODHOUSE & RAWSON'S INCANDESCENT LAMPS.

We give below a summary of the results of tests of these lamps made by the jurors at the Vienna exhibition. It will be seen that they show a very high percentage of efficiency even when run much below their normal candle power. The lower line gives the average efficiency of the whole number of lamps tested, namely 2.38 watts per c. p., or 312 candles per h. p.:

Normal C. P.	Observed C. P.	Current in ampères.	Difference of Potential in volts.	Resistance hot in ohms.	Watts.	Watts per C. P.	No. of candle per electric H. P.
20	4.64	0.779	35.24	45.26	27.44	5.91	122
	6.85	0.838	37.65	44.95	31.54	4.60	160
	8.38	0.869	38.92	44.80	33.81	3.77	196
	10.85	0.905	40.35	44.59	36.51	3.37	219
	12.18	0.926	41.21	44.52	38.14	3.13	235
	15.58	0.966	42.83	44.32	41.38	2.66	277
	20.32	1.018	44.88	44.10	45.67	2.25	327
	26.27	1.071	46.92	43.79	50.27	1.91	385
	34.24	1.126	48.93	43.44	55.11	1.61	456
	45.18	1.193	51.25	42.95	61.16	1.34	551
	Average of total number of lamps tested.						
	20.78	1.072	46.26	43.71	49.38	2.38	312

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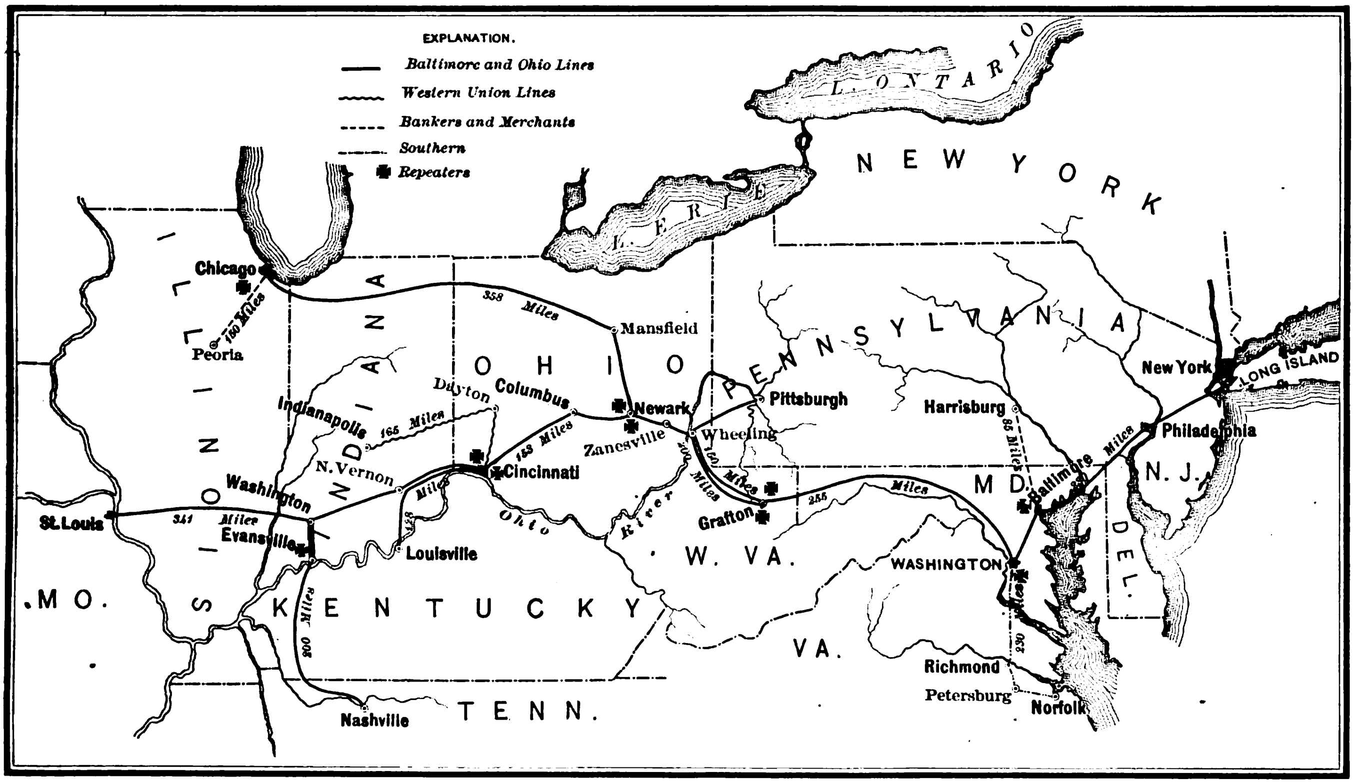
AN EXTENSIVE MORSE CIRCUIT.

UNDER the management of Mr. Walter P. Phillips, the United Press has built up an enviable reputation for its news service. This is largely due to the practical telegraphic experience of that gentleman, who has done more than any one person to facilitate the delivery of newspaper copy in the most satisfactory manner possible, by placing instruments and operators in the editorial rooms of such journals as desire to make arrangements of that character. In carrying out his ideas, he has found it necessary to transmit "direct" to every possible point, and a glance at the map given herewith, will show how well he has succeeded. The fact that at most repeating offices, an operator is required to serve a client at that point, has enabled Mr. Phillips to avail himself of that old and reliable device, familiarly known as the "button repeater." It has been somewhat improved; the repeating in both directions being effected by a single contact spring, which being almost continually in use, is properly cared for, and always bright. The automatic repeaters generally used if not constantly watched are liable to get out of adjustment, causing trouble all along the lines. As the service requires operators of the highest skill at all points, this apparently complicated circuit is managed without difficulty. The wires are leased by the United Press from the Western Union, Baltimore and Ohio, Bankers and Merchants' and Southern Telegraph companies, and operated direct from their office, 187 Broadway, New York. There is apparently no limit to the extension of this system to any point in the United States where a demand exists for the service of the United Press. The present mileage operated in one working circuit every night is 2,635 miles, as follows:

	MILES.
New York to Washington, via Philadelphia and Baltimore	230
Baltimore to Harrisburg	85
Washington to Norfolk, Va	220
Washington to Grafton, W. Va	255
Grafton to Pittsburg	150
Grafton to Newark, O	200
Newark to Chicago	358
Newark to Cincinnati	153
Cincinnati to Louisville	123
Cincinnati to St. Louis	341
Cincinnati to Dayton and Indianapolis	165
Chicago to Peoria	150
Washington, Ind., to Nashville, Tenn	200
Total mileage	2,635



WESTERN NIGHT CIRCUIT OF THE UNITED PRESS. Total length, 2,635 miles.

ELECTRIC MOTORS ON THE ELEVATED ROADS.—CORRECTED FIGURES.

BY CHARLES G. CURTIS.

IN calculating the h. p. of the locomotives on the elevated railroads, for comparison with the operating cost of obtaining the same power by electricity, as given in the March ELECTRICIAN AND ELECTRICAL ENGINEER, I omitted to add that *part* of their power which is expended in starting the train or overcoming its inertia; not supposing that this would amount to any considerable portion of the whole power. Upon calculating this item, however, it turns out that, where the stops are as frequent as three to the mile, the power required for this purpose is a large portion of the whole; and the actual power of these locomotives has been greatly underestimated—so much so, that instead of burning 15-20 lbs. of coal per h. p. hour, as supposed, they burn only between five and ten lbs.

On the Third avenue road for example, the stops are about one-third of a mile or 1,700 feet apart. Consequently for every 1,700 feet traveled by the train, its inertia has to be overcome, or in other words an amount of *living force* corresponding to its *maximum velocity* attained must be stored up in the train. The work of doing this or the energy in foot-pounds stored up in the moving train is equal to $\frac{W v^2}{2 g}$; W being the weight of the train in pounds, v its velocity in feet per *second*, and $g = 32.2$ being the *acceleration of gravity*. Assuming the weight to be 170,000 lbs., and the maximum speed reached to be about 23 miles an hour, or 33.3 feet per second, the energy would then become $\frac{170,000}{64.4} \times 1,100 = 2,890,000$ foot-pounds. That is, 2,890,000 foot-pounds has to be ex-

pended between consecutive stations in bringing the train to maximum speed, and none or very little of this energy is recovered because, as a matter of fact, the steam is kept on and the speed maintained until it is time to apply the brakes.

In other words, the locomotive must do 2,890,000 foot lbs. of work every 1,700 feet traveled by the train, in addition to that necessary to perform the work of *traction* or simply overcoming the friction. The average speed of the trains being 1,100 feet per minute, the mean foot-pounds per minute expended simply in overcoming the train's inertia would be $\frac{11}{17}$ of 2,890,000 or 1,870,000 = 57 h. p.

In addition to this the power of the locomotive is also occupied in traction or simply overcoming friction for about four-fifths of the distance between stations, steam being shut off the rest of the distance. Taking the weight at 170,000 lbs. a coefficient of traction of .004 and the mean speed at 1,100 feet per minute, the work of traction per minute would be four-fifths of 748,000 foot-pounds = about 600,000 foot-pounds, or about 18 h. p. This, added to the h. p. expended simply in imparting velocity to the train, shows the necessary power of the locomotives to be about 75 h. p. As they burn 500 lbs. of coal per hour at this mean speed, they therefore burn 6.6 lbs. of coal per h. p. hour.

It is a possible thing to get large stationary engines to furnish power at the rate of 2.5 or even 2.25 lbs. of coal per h. p. hour ; but, it is an extreme figure, and probably there are no engines now in operation that are regularly doing as well as this, especially where the power is subject to any variation. Certainly no such result as 1¾ lbs. can be safely counted upon—the figure assumed by Professor Farmer in his estimate published some months ago. But in order to favor the electrical side of the question as much as possible we will assume that the stationary engines will require only 2.5 lbs.

It does not seem safe to assume that the mean counter E. M. F. which it is practical to obtain from the motors will reach much more than 50 per cent., and this would give a net *efficiency of transmission* of about 40 per cent. Here, again, Prof. Farmer has based his estimate upon another very extreme figure,—a net efficiency of about 80 per cent., which seems not only not warranted by fact but apparently impossible under such conditions. If the net efficiency be taken at about 40 per cent., it would require 2.5 times 2.5 lbs. or 6.25 lbs. of coal per hour to furnish each h. p. on the track. When we compare this with the 6.6 lbs. required under the present arrangement, the saving would be very little, if anything. One consideration in favor of stationary engines is the possibility of using cheaper coal than the locomotives require, but if this were the only advantage, it would obviously not be worth while to apply electricity to the elevated railroads.

There does not seem to be margin enough to work on, and it is only by assuming extreme figures against steam and in favor of electricity, that a material showing in favor of the latter can be made.

ON AN AUTOMATIC CUT-OUT FOR CHARGING SECONDARY BATTERIES.

BY GEORGE B. PRESCOTT, JR.

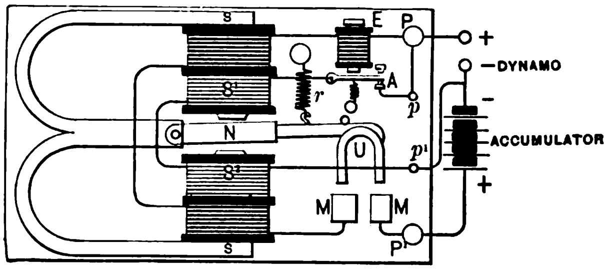
THIS instrument consists of a double coil, polarized electro-magnet, and armature, in which one coil automatically connects the charging dynamo to the battery whenever its E. M. F. exceeds that of the battery, while the other maintains such connection until the E. M. F. of the battery nearly approaches that of the dynamo. The polarization of the electro-magnet prevents damage by accidental reversals of the circuit current, whether such reversals occur suddenly whilst charging or otherwise.

In the accompanying schematic illustration S, S, represent the south poles of two powerful horse-shoe magnets whose opposite ends are united into a common north pole, which is extended by the soft iron armature, N. Attached at right angle to each of the south poles are soft iron cylinders forming the cores of electro-magnets, s1, s2. These electro-magnets are each wound with two coils, whose magnetizing effects coincide, one composed of a few turns of thick and the other of many turns of thin wire, the latter being superposed.

The thick wire, or main circuit ending at the binding posts, P, P1, includes the electro-magnet, E, and the mercury cups, M, M, the latter forming a "break" which is closed by the bent wire, U, carried on the end of the armature. The thin wire, or shunt circuit is completed to the binding posts, P, P1, through the armature and back stop of the electro-magnet, E.

By means of the spring, *r*, a bias is given to the armature, N, toward s1, as otherwise it would be attracted indifferently by s1, or s2, according as it happened to be nearer to one or the other. The armature is, therefore, normally against s1, and in this position leaves the main circuit broken at the mercury cups.

It will be seen by reference to the diagram that the thin wire coils act as a shunt about the poles of the dynamo. When the latter is "started up" its current flows through



PRESCOTT'S AUTOMATIC CUT-OUT.

the shunt coils in such a direction as to reverse the magnetism of s1, making it, therefore, a north pole, at the same time increasing the magnetism of s2, making it a still stronger south pole. The armature, N, is consequently repelled by s1, and strongly attracted by s2. The retractile spring *r*, is, however, so adjusted that it counteracts the tendency of the armature to move toward s2, until the E. M. F. of the dynamo has reached a certain predetermined limit. This limit must be, of course, an E. M. F. greater than that of the battery to be charged, and as soon as it is reached the armature moves over to s2, closing the break at M, M, and allowing the whole dynamo current to pass through the battery. The main coil now holds the armature; the electro-magnet, E, having become energized and broken the shunt circuit at A. As the battery becomes charged its E. M. F. rises, and when it nearly equals that of the dynamo (which it opposes, of course,) the current circulating in the main coils becomes too feeble to resist the spring, *r*, which therefore pulls the armature back to its original position against s1, and breaks the main circuit at the mercury cups. The same conditions would arise and the cut-out would act in the same manner should the E. M. F. of the dynamo fall off, from any cause, or disappear entirely as it would if the driving belt should break. In the latter event, however, the reverse current from the batteries might traverse the circuit before the retractile spring could act (commonly the case with ordinary cut-outs), but just here the action of the polarized magnet is utilized, for this reverse current makes a north pole of s2, and increases the south polarity of s1. The armature is thus repelled by s2, and attracted by s1, besides being pulled back by the spring *r*, and so, as before,

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breaks the circuit at the mercury cups. The reverse current is thus rendered harmless by its own action.

When once properly adjusted the cut-out requires no further attention. It will connect the dynamo to the batteries whenever the dynamos' E. M. F. has reached the predetermined limit, and disconnect it whenever the E. M. F. falls below the limit and when the batteries become charged. It may be located with the battery at consumers' residence, and is particularly adapted to intermittent power.

WESTON LABORATORY, NEWARK, N. J., April 4, 1885.

RADIATION vs. ELECTROLYSIS.

BY FRANK C. LOCKWOOD.

Scientists—and doubtless many who are not yet worthy to be called scientists—have noticed the metallic deposit which sometimes appears upon the inside of the globes of incandescent lamps after they have been continuously in use for a considerable length of time. The cause of this deposit is, of course, well known ; it being nothing more than the result of the decomposition of the copper or carbon or both, but deductions therefrom have sometimes been hastily and erroneously made.

We have recently had occasion to examine a lamp which has been in use a long time in the premises of a large silver-ware manufacturing firm in this city. It is an ordinary 16-candle Edison lamp, and at present has almost the appearance of a solid globe of bronze, so great is the deposit of copper within it. The explanation, as we have said, is apparent ; electrolysis of the copper has resulted in the fourth condition of matter, and not, as ordinarily in cases of this kind, in the third or gaseous state. The peculiar effect is due in part to radiation and not simply to decomposition. This is demonstrated by the directions taken by the matter, and by the fact that the distribution has taken place from one point, which so far as can be judged, is one of the copper clamps holding the filament of carbon. It is also verified by the fact that from the top of the lamp to where the other clamp is situated a thin line of clear glass may be observed, following the line of the carbon filament and evidently protected by it from the deposit of particles proceeding from the centre of radiation. It is a somewhat novel phenomenon and we think on that account deserves notice. Aside from the elaborate experiments of certain physicists the often peculiar and sometimes startling effects of the fourth condition of matter have perhaps not received the attention they are justly entitled to. The study of these phenomena is at once entertaining and instructive, and undoubtedly will in time become more general than it is at present.

CREDIT TO WHOM CREDIT IS DUE.

WE are not in the habit of troubling our readers with complaints, when our esteemed contemporaries borrow our original articles, as they sometimes do, without giving the slightest intimation of the source from whence they were derived, but we must in fairness insist upon such extracts being credited, if at all, to their proper authors. We would therefore respectfully represent that the table of electro-chemical equivalents which was published in *L'Electricien* of February 7th, was prepared expressly for us by George B. Prescott, Jr., of the Weston Electric Light Co., of Newark, N. J., who should not be mistaken for the well-known author of *Electricity and the Electric Telegraph*. This table appeared on page 7 of the January number of THE ELECTRICIAN AND ELECTRICAL ENGINEER, and certain corrections thereof will be found on page 72 of the February number, to which we desire to direct the attention of all interested.

ABSTRACTS AND EXTRACTS.

REAR COLLISIONS ON RAILROADS.

WE call attention to reports of the occurrences contained in our imperfect record of accidents for October, 1884, from which it will appear that 17 out of 29 rear collisions therein noted were strictly tail-enders, which might have been avoided by the proper use of the simplest block signals, maintaining a positive interval between the trains which were following one another.

All of these events except one, so near as we can make out, were due to the bad dependence placed upon bad flagging. As nearly as may be gathered from the reports, at least four persons were killed, 31 persons were injured, 12 engines were wrecked, and 82 cars were destroyed or crippled in these disasters.

In attempting an estimate of the damages resulting from them we shall probably fall far short of the truth, because we have no details from which we can calculate the loss of traffic suffered during the blockade of tracks resulting from a disaster of this kind, nor the cost of clearing up the wrecks, nor the injury done to the tracks, nor the value of the contents of the cars which were destroyed or injured, nor the loss which always must ensue from a destruction of confidence in the safe management of the roads upon which these collisions took place ; but we have estimated these unknown quantities at the very moderate sum of $500 for each accident. The value of a human life we have taken at the rate fixed by law.

Our estimate of damage stands as follows :—

12 engines wrecked	at	$1,000	each	$12,000
82 cars wrecked	at	200	"	16,400
4 persons killed	at	5,000	"	20,000
31 persons injured	at	100	"	3,100
Conjectural damages, 17 instances	at	500	"	8,500
Grand total				$60,000

or about $3,530 for each tail-ender. From what we have personally seen of these misfortunes, we cannot regard this as probably too high an average.

Estimating the cost of a good block-signal semaphore at $75, the $60,000 which we have estimated these disasters to have cost would have furnished 800 stations with semaphores ; these stations being placed five miles apart, this outlay would have provided for 4,000 miles of railroad ; and, proceeding at this rate, in 30 months the entire railroad system of the United States might be equipped with suitable means of preventing this description of accident.

Or, looking at the subject in another way, if by the adoption of the very simple block system described in the *Railroad Gazette* of November 7, 1884, a railroad should escape *one* tail-ender of the average cost which we have estimated, it will have recovered the expense of equipping 47 stations, or at distances of five miles, as before, 235 miles of line. It is very clear from these figures, that a railroad with any business worth considering, can better afford the signals than it can the tail-enders. On many roads it would perhaps not be necessary to add one man to the staff ; on others it might require the addition of several night telegraphers, and on still other roads, where attention has not been paid to the advantage which may be derived from employing as agents at small stations persons who are also telegraphers, it might require the establishing of telegraph offices at points which now have to do without them. Yet, making the largest possible allowance for these contingencies, we feel assured that it would be better to meet the cost of them, than to suffer from accidents which are so clearly preventable by the adoption of the simplest precautions.—*Railroad Gazette*.

ARC-LAMP CARBONS.*

ALTHOUGH improved processes and enlarged experience must inevitably lead to greater perfection in the manufacture of carbons, they are not yet by any means satisfactory.

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In commenting upon this subject the London *Engineer* says that the two greatest defects which arc lighting can have are flickering and noise. Variations in the amount of light are of secondary importance. If a lamp flickers, the defect is simply fatal. As a rule, flickering is not caused by a defect in the lamp, but by the imperfection of the carbons, or the improper manner of using them. It seems to be proved that, on the whole, the best results are got by using carbons about 10 or 11 mm. in diameter below and 12 mm. above, the upper carbon being, of course, the positive, with a current of 8 to 12 ampères, and an electromotive force of 35 to 40 volts. The h. p. in the first case will be $\frac{8 \times 35}{746}$, or ·37 h. p. In the latter case we have $\frac{12 \times 40}{746}$, or, say, ·64 h. p. This is rather too much for carbons of the stated size, and it will be found almost impossible to make the lamp burn steadily and without noise. The large current tears the carbon points to pieces. If it is still further augmented, flaming sets in, and the light is positively reduced instead of being augmented. Now, every carbon requires a special current and electromotive force which will give a better result than any other; and when the current is kept small, and the electromotive force moderately high, absolute steadiness may be secured.

The struggle to get the greatest possible quantity of light out of a lamp has ruined the reputation of many good lamps. No matter what the current may be, some carbons will never burn quietly, the reason being either that gases are occluded in the carbon, or that substances are left in it which will produce them. In estimating the good qualities of a carbon, the first thing to be considered is its conductivity; if this does not exist in a high degree, it must be rejected without ceremony, no matter how good it may be in other respects. It will become very hot when the current passes through it, and will rapidly waste, tapering away to a point from its proper thickness for a length of two or three inches. The carbon holder of the lamp may be burned, and much mischief done. We have seen carbons quite silent and giving out a magnificent light, which were worthless because of their high resistance. Attempts are made to get over the difficulty by coppering the carbons by the electrotype process, but the result is not satisfactory. No adequate explanation of the causes of want of conductivity or the reverse has ever reached us. Two carbons made by the same process, at the same time, and from the same materials, may be found, one of which will prove excellent, while the other will not conduct at all. So far as can be gathered, the conducting power depends more on the molecular structure of the carbon than on anything else.

Conductivity secured, the next thing to be sought for is silence and absence of flickering, and these can be had in only one way, namely, by purifying the coke in the first instance from which the carbons are made. The best material seems to be the linings of gas retorts; but this ought to be treated with caustic potash and carefully washed. This is not the place to go into the details of manufacture. We must content ourselves with general principles. The best carbons and the best lamps will give bad results if, as we have said before, the current is not just right; and one point, frequently neglected, ought to be insisted on, namely, that the speed of the dynamo shall be kept constant. The resistance of the arc varies continually. It is instructive to put a single arc lamp in circuit, and then watch the hand of an ampère meter. This will seldom or never be quite at rest. If the carbon is a bad one the hand will jump through comparatively large ranges, each sputter of the carbon being attended by a jump. When there are a good many lamps in series, a little overfeeding or a little underfeeding may considerably alter the resistance, and unless there is plenty of power and a good governor, the result will be unsatisfactory. Thus, for example, let us suppose that a little overfeeding takes place. The resistance is diminished, the quantity of current augmented, and more load is thrown on the engine. If it is properly governed it will keep its speed constant, and the lamps have a chance of recovering themselves. If, on the contrary, the speed falls off, the lamps will get worse and worse. It is only too often assumed that arc lights do not need regular speeds; but this is quite a fallacy. They want it quite as much as the incandescent system.

THE INTERCHANGEABLE SYSTEM.

Latterly considerable discussion has arisen as to when and by whom the system of interchangeable parts was introduced in mechanical processes. Inventors both in this country and abroad have been credited with the high honor; indeed, so many persons have been thrust into prominence as rightful claimants that the curiosity to know to whom the mechanical world owes its thanks and praises is whetted by the desire to see simple justice done. From all that can be learned it appears that sample guns with parts to interchange were made in France as early as 1717, and again in 1785, but for lack of machinery, presumably, attempts to reduce the feature to practical use failed. Eli Whitney, of cotton-gin fame, took up the idea in this country, and introduced the plan of filing the component parts to hardened jigs, by which an approximation was made to the uniformity system, but not sufficient to make them interchange without extra labor in filing, which was too costly for general use. Gen. Wade, of the United States Army, credits Hall, of Harper's Ferry and breech-loader-rifle fame, with the first successful attempt ever made in this or any other country to manufacture arms upon this principle. Hall's rifles, according to Gen. Wade, were manufactured under the supervision of the inventor, who introduced the system in 1827–8 of making all the parts of the arm interchangeable. But according to an extra census bulletin issued in 1882, or rather according to an official report published therein from the pen of Charles H. Fitch, the system was first carried out as a success at the United States armory, at Springfield, and that success was due more to Thomas Blanchard's invention than those of other persons. Blanchard's inventions were numerous and of great value. He brought out a lathe which would work to any given model placed before it, be it round, square, crooked or straight, and rapidly and exactly reproduce the original form every time. He also constructed an ingenious tool for mortising in the lock. No kind of glove could be fitted more closely to the human hand than did the mortise to the lock. In 1842 the armory at Springfield achieved the great triumph of merging individuality of parts in numbers, and all distinguishing marks of letters and numbers were discontinued at once and forever. Thus after a slow growth of twenty-three years in United States armories, or from September 6, 1819, the date of Blanchard's early patent, to 1842, the system attained its full growth and perfection. During these years there were two national and six private armories in the United States service employing first-class mechanics, and they nearly all contributed something; some new motion or some new process to the common result.—*Age of Steel.*

A TOWN ELECTRICALLY LIGHTED BY WATER POWER.

At Bellegarde, in France, M. Dumont, a manufacturer, has thrown a dam across the Valserine, a stream yielding 1,100 gallons per second, and affording, with 165 feet fall, at least 2,000 h. p. A 600 h. p. turbine drives, among other machines, 2 Gramme dynamos, the current from which is led by copper conductors on poles, to Edison incandescent lamps distributed about the town.

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LITERATURE.

REVIEWS.

Electricity and the Electric Telegraph, by GEORGE B. PRESCOTT. Sixth edition, revised and enlarged, with 670 illustrations (2 vols). New York: D. Appleton & Co., 1885.

IN the first edition of Mr. Prescott's work, which was published in 1877, the apparent design was to cover with as much completeness as possible, the practical aspect of the mo ern electric telegraph, and, to a certain extent, to trace its historical development. A considerable share of attention was also devoted to a discussion of the various theoretical considerations upon which the operation of the different kinds of electrical and telegraphic apparatus depend. No work had hitherto been published in the English language designed to occupy precisely this field. The nearest approximations to anything of the kind were the excellent works of Dr. Schellen in the German and of Blavier in the French language. In the preparation of the original work Mr. Prescott followed pretty closely the general plan of Schellen's work, both as to the arrangement and the treatment of the subject-matter, and in fact much of the purely theoretical portion of the work was essentially the same as that of Dr. Schellen, which was conspicuous for its clearness, simplicity and admirable adaptation to the wants of students and investigators. Building, therefore, substantially upon the general lines of Dr. Schellen's work, Mr. Prescott extended, enlarged and amplified it by the addition of a vast amount of new and valuable material, relating especially to the details of the telegraph work in the United States and in Great Britain. At the date of the publication of the first edition, therefore, no other treatise could be mentioned at all comparable with that of Mr. Prescott, in respect to the variety and extent of information relative to the American telegraph system, which was then confessedly in advance of that of any other country in the world, whether judged by the actual amount of business handled in proportion to the cost of the working plant, or in the shortness of the average time occupied in transferring a communication from the hands of the sender to those of his correspondent.

At the date of publication referred to, the quadruplex system was scarcely three years old, the telephone was a feeble infant lisping its first accents, and the electric light was nothing more than a philosophic toy, or at most an interesting laboratory experiment. Eight years have passed since then, but how changed the aspect of affairs in the electrical world! Then the portion of the electrical field outside of telegraphy was comparatively insignificant; to-day telegraphy is only one of a number of important interests which have suddenly grown up, as it were, in a night, some of which threaten in the not distant future to overshadow it altogether.

The modifications which the American telegraphic system has undergone since the introduction of the quadruplex have been few and unimportant, and in fact it may be said that there have been no innovations introduced worthy of special note, unless the application of dynamic electricity to telegraphy may ultimately prove to be such. Nevertheless, the great demand for Mr. Prescott's work, which has already exhausted five editions, has been such as to justify him in making some revisions and adding a considerable amount of new matter to the original work—additions which have increased its bulk to such an extent as to render it advisable to issue it in two volumes, a change which has been effected without any increase in price.

In the present edition we observe that considerable new matter has been added, having to do with the quadruplex system. Descriptions and illustrations of some of the earlier attempts at the solution of this interesting problem, made many years ago in Germany, are given, while the practical telegrapher will find much of importance and value in the various modifications of apparatus which are illustrated and described, having for their object the adaptation of the typical or standard system to the almost innumerable special conditions which arise in the telegraph service under different circumstances. A chapter on the application of the duplex methods to submarine cables will be found of much interest. It contains descriptions of the systems of De Sauty and Harwood, and of Muirhead and Taylor. The French system of Ailhaud, which, however, is adapted only for short cables, is also explained and illustrated. The method of Mr. J. B. Stearns, which is employed on the Anglo-American cables between Newfoundland and Ireland, is not described, and in fact we believe no complete description of it has ever been made public. A new and valuable chapter on electrical measurement has been inserted, which is essentially the same in subject-matter and treatment as that which we have already referred to in our notice of the author's work on dynamo-electricity.

The remaining additions are mostly of a miscellaneous character, relating to such subjects as electric call-bells, the Western Union time service, Siemens's electric furnace, Maxim's automatic fire extinguisher, Brooks's underground telegraph system, Lewis's improved insulator, and D'arlincourt's relay. Mr. Delany's interesting system of synchronous multiple telegraph is described, and there is also a discussion of the comparative advantages of the different forms of electro-magnets, extracted from Du Moncel, which cannot fail to be of frequent use to practical electricians.

On the whole, the improvements which have been made in the present edition may be said to add greatly to the value of the original work.

The mechanical execution of the volumes is admirable in every respect. The typography is clear and tasteful, the engravings are executed in the best style of the art, the paper is of good quality and not too thick, and the binding neat and substantial. We mention these points for the reason that it is becoming of late too much the fashion for publishers to send out books which are deficient in one or more of these particulars, a fault which it is fair to say is seldom found in scientific works bearing the imprint of Messrs. Appleton & Co.

Transactions of the American Institute of Electrical Engineers. Vol. I. May-October, 1884. New York: Published by the Institute (1885).

THE Institute of Electrical Engineers, which was organized in the spring of 1884, held its first general meeting at Philadelphia during the International Electrical Exhibition which was given under the auspices of the Franklin Institute in October following. The meeting was a very satisfactory and successful one, and a number of papers of interest were read and discussed by the members and others present, most of which have now been collected and published as volume I. of the "Transactions of the American Institute of Electrical Engineers."

This volume, which has just been issued by the secretary of the Institute, is prefaced with a brief historical sketch of the organization of the society, but the bulk of it is occupied by the papers and the discussions which arose from them at the meeting.

Professor E. J. Houston, of Philadelphia, has a short paper describing certain peculiar phenomena in an incandescent lamp exhibited by Mr. Edison at the exhibition. A discussion ensued, in which Mr. W. H. Preece and Mr. N. S. Keith each took a prominent part, but no very definite opinions were ventured as to the cause of the phenomena. Mr. Preece expressed his intention to make a careful investigation after his return to England, and the results of his labors in this direction will be found in his paper which we republish in our present issue.

Mr. W. M. Callender's paper on underground wires, although particularly devoted to an exposition of the merits of his own wares, is, nevertheless, by no means wanting in information of general value. Mr. Preece remarked that from his experience as an officer of the post-office telegraphs, he could confirm all that Mr. Callender claimed for his material.

Perhaps the most suggestive and interesting paper in the collection is one by Rowland R. Hazard, under the title of the "Scientific City Street,"—not that there is anything intrinsically novel in the plan proposed by Mr. Hazard, but that the details have been carefully thought out by him and embodied in a definite working plan, of which a handsome lithographed drawing in four colors accompanies the paper, illustrating the practical application to such a street as Broadway, New York. The plan embodied in Mr. Hazard's paper is worthy of far more careful consideration than it is likely to receive at present, although nothing can be more certain than that an ultimate reconstruction of Broadway will inevitably be forced upon us. That in such case it will be rebuilt upon substantially the plan proposed by Mr. Hazard we have no manner of doubt. The scheme may be briefly described as a continuous arcade beneath the carriage way, affording room for four parallel lines of railway, two on the outside for way trains and two in the middle for through trains. Between the arcade and the curb on each side is a space four feet six inches in breadth, which may be made of any required depth for the accommodation of pipes and wires of every description. The space underneath the sidewalks is reserved for vaults for the accommodation of adjacent buildings. The trains on this subterranean railway system are of course designed to be propelled by electricity. Professor C. F. Brackett, of Princeton, N. J., presented a brief but suggestive paper, giving an account of his method of experimentally investigating the characteristics of the dynamo machine by means of an exploring coil, whereby the value of any point in the magnetic field may be instantly determined. An excellent paper, in the characteristic and well-known style of Thomas D. Lockwood, on the subject of earth-wires, was presented by him. After a thorough discussion of the subject, the author reaches the conclusion that no earth-wire and plate should offer a resistance of more than 10 ohms, and that earth-wires at opposite terminals of a circuit should always be composed of similar metals; conclusions which may be said to possess less intrinsic originality than the methods of investigation by which they were reached. S. J. M. Bear, of Iowa, gave an account of a curious experiment in the transmission of telegraphic signals through water without the aid of wires.

We have no room to give an adequate summary of the exceedingly interesting paper of E. P. Thompson on the chemistry of

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the carbon filament, in which the peculiarities of the various processes employed by Weston, Edison, Swan and others are discussed and compared. The account given by the author of his own investigations in the manufacture of carbon filaments from animal matter will attract special attention. It is a matter of regret that the discussion which followed this paper elicited so little additional information of importance from those present, some of whom were apparently well qualified to impart it.

Finally, we have to notice a forcible paper on the needs of the Patent Office and the relations which it sustains to inventors, by C. J. Kintner, principal examiner of the division of electricity. Mr. Kintner's paper is but a reiteration of the considerations which have often been urged in our own columns, as to the insufficiency of the accommodations and the utter inadequacy of the present numerical force of examiners to cope with the rapid increase of applications, whereby the most vexatious and exasperating delays are caused, and great consequent damage inflicted upon the interests of patentees and patent owners. He has, however, set forth the difficulties under which the examining corps are compelled to labor, in a manner calculated to convey a particularly vivid idea of them. In fact the feeling which will be uppermost in the mind of any candid person after reading this paper will probably be one of wonder that the work is done half as well as it is, especially in the electrical division. It is gratifying, however, to be able to say that, by some means or other, an improvement has been effected since the advent of the new administration, for the last month has certainly shown a visible acceleration in the movements of the machinery of the Patent Office.

Taken as a whole, the contents of the first volume of transactions are exceedingly creditable to this vigorous young society. The publishing committee have performed their work in an eminently satisfactory manner, and it is only to be regretted that the volume is not consecutively paged, owing to circumstances beyond the control of the committee, a defect which we are assured will not be permitted to occur in the case of subsequent volumes.

RECENT PUBLICATIONS.

Fournier, G. La Lumière Électrique dans les appartements. Paris: *Bernard Tignol*, 1885 [1884]. 36 p. 12°.

Schwartze, Th. (Edition Française par G. Fournier.) Le telephone, le microphone et le radiophone. Paris: *Bernard Tignol*, 1885 [1884]. 244 p., illustr. 12°.

Stiles, A. Tables for field engineers. Philadelphia: *Jas. W. Queen & Co.*, 1885. 156 p. 16°. (Pocket.)

National Conference of Electricians. Proceedings of Philadelphia meeting (1884). New York: *W. J. Johnston*, 1885. 300 p. 4° small.

QUESTIONS AND ANSWERS.

[62.]—**A. J. N.** We are always pleased to receive such information as you gave in your letter of April 15th, and shall be glad to hear from you again.

[63.] **Battery for Electric Motor.**—J. H. S., St. Louis, Mo., says: I am making a motor on the plan recently described by Mr. Chaster, but of twice the dimensions, the armature being 6 in. long and 3 in. in diameter. What is the best size and amount of wire to use with the gravity battery, say 10 or 15 cells 6 in. by 8? **Ans.**—It is impossible to run anything larger than a toy motor with the gravity battery. It is not at all adapted for the purpose. The only battery suitable for operating a motor is a bichromate or a nitric acid battery, respecting which we design to give full information at an early day.

[64.] **Electric Circuits without Wires.**—C. F. W., N. Y., says: 1. Please inform me if there is any way of completing a telegraphic circuit without a continuous wire. 2. How many ohms resistance and how many cells of battery would be required to operate a telegraphic line from Jones to 44th st.? **Ans.**—1. No practical means has yet been discovered of transmitting signals for any considerable distance without wires. 2. Use a No. 11 iron wire, instrument of about 50 ohms resistance, and 8 or 10 cells of gravity battery, or its equivalent.

[65.] **Construction of Electric Motor.—Working Capacity of same.—Batteries.**—C. N. of Toronto, Ontario, says: 1. I wish to construct an electro-motor similar to the one described in the ELECTRICIAN AND ELECTRICAL ENGINEER. Can the field magnets be made of 2½ in. iron gas pipe, the poles to be fastened to the inside and afterwards bored out to the required diameter? Such magnets would hold nearly as much wire as the pattern described while the iron would be of better quality. 2. Will the motor run a small screw cutting lathe with a battery of 8 bichromate cells? 3. Is there any battery which after once setting up will require any further attention until fully exhausted, develop no local action when not in use, and only require switching on when the motor is to be used? 4. How can I anneal cast iron? **Ans.**—1. The machine will be less efficient with the hollow cores. It is possible that this might be compensated by the better quality of iron but we think it doubtful. 2. We think so. 3. No. Such a battery would ensure a fortune to its inventor. The nearest approach to it is the bichromate battery, when so arranged that the plates may be withdrawn from the solution by a windlass when the battery is not in use. 4. The castings should be of charcoal-iron of the best quality. They are first scoured to free them from sand and scale and then packed in an iron box with fine iron scales from a rolling mill, which is closed at the top by a mixture of sand and clay, and all the cracks luted to prevent the admission of air. The box is then subjected to white heat in the annealing oven for several days, and allowed to cool very gradually. This can be best done at a malleable iron works.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Electrical Power not yet "on Tap."—The Van Depoele System in the East.—Proposed Retirement of Mr. Cyrus W. Field from Active Business.—Bids for City Street Lighting.—The Gas Consumers' Association.—Subterranean Wire, Work.—Bankers and Merchants' Bonds.

THE mechanical trade papers, and a great many of our citizens, are rather skeptical about the successful adoption of electricity for traction purposes on the elevated railways.

In the early stages of electric lighting, much was said about the utilization of the central plants for distributing power during the day. This was to be an important feature especially of the Edison down-town system, as it was well understood that the average demand for artificial light in the lower wards of the city is very limited. So far there have been no active indications of a desire to occupy this field, although an electric fan, which occupied a prominent position at the Philadelphia exhibition, has been hinted at as a probable channel into which electrical energy might be diverted. This seems to be very little fire for so much smoke, and as there is certainly in Nassau street and Maiden lane a fine field for such light power as it was proposed to furnish, we think it would certainly give a better business appearance if an effort was made in this direction, before undertaking to supplant steam on the elevated railways.

There is a plan on foot for the invasion of Eastern territory by the Van Depoele Electric company of Chicago, the first step of which appears to have been the organization of a company at Elizabeth, N. J., with a nominal capital of $250,000, to exploit the various electrical devices which are manufactured under the Van Depoele patents. It has been announced that a tower to light the bankrupt city would be erected near the Union depot, but as yet there has been no announcement as to where the cash was coming from. If the city is to be lighted as an advertisement of the tower system, the tax-payers will no doubt be pleased.

It has long been the expressed intention of Mr. Cyrus W. Field to retire from active participation in business upon the completion of his fiftieth year of service in the commercial world. Having reached this period within the past few days, he has severed his official connection with the various companies with which he has been associated, including the Manhattan Elevated Railway and Western Union Telegraph companies. He retains his financial interest, however, in the enterprises in which he has been prominent. His place in the executive committee of the Manhattan Elevated company has been filled by his eldest son. As soon as Mr. Field has wound up his pending business he will start for Europe, and after a brief stay in London, in connection with some legal matters there, will start on a trip around the world.

The bids for street lighting for the coming year by the local Brush and United States companies, were the same as last year, 70 cents per night for each lamp—$255,50 for one year. When the contracts are made for the work, their overhead wires will probably not be disturbed by the "underground" commissioners until after their terms expire.

The disgruntled gas consumers have organized under the title of the Gas Consumers' Association of the State of New York. Its objects are announced to be as follows: To obtain, preserve, and circulate information of value to gas consumers and the public generally; to secure adequate inspection of meters, so that consumers may get what they pay for, gas being the only commodity which is not habitually measured by standards established and maintained by public authority; and to impose upon companies furnishing the public with light such just restrictions as are recognized elsewhere as necessary for gas and other corporations exercising a public franchise, where the interest of consumers is not protected by the law of competition, and where the individual citizen cannot successfully maintain his rights against large organizations.

John H. Sherwood, Jackson S. Schultz, William D. Garrison, Sheridan Shook, Robert M. Strebeigh, Francis B. Thurber,

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William H. Webb, Theodore Moss, Henry M. Smith, and Frank S. Gardner, are the charter members.

With the advent of fine weather, the work of placing the telephone wires of the city underground has been renewed. Broadway above 21st street was opened on the 19th, and the pavement replaced before Monday morning. The wires are to be run as follows from the 21st street exchange: To the corner of 4th avenue and East 21st, 217 wires; to corner 6th ave. and West 21st, 271 wires; to corner Broadway and 19th, 205 wires; to corner Broadway and 23d, 307 wires; making a total of about 1,000. This of course, is but a small fraction of a single system of overhead wires.

The claim of Mr. A. G. Day against the Bankers and Merchants' Telegraph Co., was secured by mortgage bonds for $334,000 par value. He obtained judgments for $18,000 against the company in Illinois, which with the bonds were subsequently assigned to Edward S. Stokes. An injunction was granted by Judge Donohue about two months ago restraining Stokes from enforcing the judgments or disposing of the collateral. On the ground that the bonds have a market value of only 5 per cent. of their par value and are continually depreciating, thus lessening the security for his judgments, Stokes obtained from Judge Barrett, in Supreme Court Chambers, an order permitting him to sell them.

NEW YORK, April 20, 1885.

PHILADELPHIA.

The Latest Scheme to Revolutionize Telegraphing.—What the Hathaway Printer is Expected to Accomplish.—The "Underground" hearing at Harrisburgh.—The Fottrell Cable for Subterranean Work.—Permission Granted for an Electric Railway in the Park.

"A NEW application of electrical science has been made here that *promises* to go far towards revolutionizing telegraphy and supplanting the telephone in popular favor."

According to this statement, all that is necessary for one to do to become a full-fledged, strictly first-class telegrapher, is merely to learn to write on a type-writer and presto! it will be the merest play for any one to transmit or receive messages—perhaps. If this new "wonder" is capable of doing all that is claimed for it, what is to prevent girls, clerks, expressmen, station agents, carpenters, car drivers, *et al*, from ousting the expert Morse operators and filling a long felt want? Clearly, nothing. For reasons best known to the company controlling this most important invention, its operations have until now been kept a secret. The office and operating rooms, at 327 Walnut street, have been carefully guarded against reporters, and the men interested have been as close-mouthed as if it had been a political mystery, instead of a step in progressive science that they were concealing.

The distinguishing features of the new system—which takes its name from the inventors, Messrs. George M. Hathaway and James H. Linville—are the entirely novel transmitter and receiver employed. Those two instruments, although put near together here upon a table, have between them about a hundred miles of ordinary telegraph wire coiled about the room, through which their connection is made. In point of fact, the transmitter and the receiver are exactly alike, the same machine serving for either use as required. Its front is almost the same as the key-board of a caligraph or type-writer, the letters of the alphabet and the numerals standing up on elevated keys. There is nothing extraordinary in the printing mechanism, but the novel principle of the instrument is, that the different characters are printed by current pulsations of various strengths.

One of the gentlemen connected with the new enterprise said: "The distinctive advantages claimed by this system over all other telegraphic, telephonic and type-writing instruments are in its simple and inexpensive construction, and the ease of operating it. Any person who can read can transmit and receive messages through it as correctly as could the most experienced expert using the Morse instrument. It is as rapid as it is accurate, and all messages by it being automatically printed, both at the point of transmission and that of reception, they can be received with safety and reliability in the absence as well as in the presence of the recipient. The recording of messages at both points precludes all questions of errors in transmission. It cannot be read by sound, and is consequently the only method for preserving privacy in electrical communication. It is at once a stock indicator, telephone and type printing telegraph. For railroad and express companies, bankers, brokers, merchants and all commercial purposes—it being adjustable to any system of wire communication and capable of working with any number of tributaries—it is of inestimable value. It is not a verbal telephone, but will supersede that instrument by silently and rapidly recording all messages upon paper. There are no formidable complications in its construction, and it is regarded by expert electricians as a wonderful achievement."

Greater confidence could hardly be shown by capitalists in a new invention than that demonstrated by the company of Philadelphians who control the Hathaway patents. They have issued $2,000,000 of capital stock in 200,000 shares, but no shares are for sale, even at par. They propose to hold all as an investment. The officers are: president Thomas Cochran, president Guarantee Trust and Safe Deposit Company; vice-president, J. H. Linville, C. E.; treasurer, Thomas T. Butcher; secretary, Wm. H. Wile, secretary Southern Maryland R. R. Co. Only territorial rights are to be disposed of.

At Harrisburgh further arguments on the underground wire bill were heard by the Senate Judiciary General Committee on the afternoon of the 14th, and Samuel B. Dixon, counsel of the Brush Electric Light Co., made his main theme the unconstitutionality of the bill unless it be amended to provide for compensation for the wires, poles and other property proposed to be taken. Henry Metzgar, of the Bell Telephone Co., of Pittsburg, and A. J. DeCamp, manager of the Brush Electric Light Co., of Philadelphia, presented an array of facts and figures designed to show the impracticability of the bill. Manager Palmer, of the Brooks Underground Co., spoke for the bill, pointing out many instances in which buried wires have been and are now being used with success.

I have in my possession several pieces of a cable manufactured by Mr John Fottrell of this city, which appears to be admirably adapted for underground work. The material used is extremely cheap, waterproof, and very durable, the effect of the earth being to harden and preserve it. Several tests of this cable have been made by practical electricians. Mr. George W. Porter, of the Western Union in this city, tested it and found it perfect—not getting the slightest deflection through an Elliot galvanometer. Mr. George A. Hamilton, electrician of the Western Union company in New York, also tested it. He found no leak in it, but thought the specific insulation too low for general telegraphic purposes. Mr. Fottrell has been a close student of chemistry for years. He has also been in the telegraph business for a long time and ought to know something about such matters. One of the pieces in my possession has been buried in the earth for eleven months and is better to-day than when put down. It would be just as easy to make this cable with a high as with a low insulation.

At a meeting of the Electric Committee of Councils the ordinance of the Northern Electric Light Co., granting permission to erect poles and stretch wires for electric light purposes on Frankford avenue, Kensington avenue, Norris street, and other streets in the upper section of the city, was amended and ordered to be reported to Councils with a favorable recommendation.

Park superintendent Thayer reported favorably yesterday to the Improvement Committee of the Park Commission, an application to build an electric railway in the Park, made by the Bidwell Electric Motor Co.

PHILADELPHIA, April 18, 1885.

CHICAGO.

Rapid Increase of Incandescent Lighting.—Isolated Plants Among the Theatres.—Proposed Substitution of the Electric for the Cable Railway.—Explosive Subterranean Conduits.—More Rest for the Firemen.—The Baltimore and Ohio Subterranean System.—A New Telegraph Company.—Telephone Affairs Quiet.—How to Avoid Shocking Results from Dynamo Circuits.

THERE are fluctuations in electric lighting as in other enterprises. The dear public wants more and better light than gas jets furnish. Prime cost is, of course, an item worth considering—but the extra outlay has its compensation. Convenience, health and cleanliness weigh down the scale beam in the argument, and the public says "hang the expense, give us more light." The arc was first in the field, and paved the way, and the more modest glow lamps followed suit. Each has its place for which it is best fitted, and while the first has partially occupied its field, the lesser shiner has just begun to assert itself in a more extended way, while the former is taking a comparative rest, for a short season.

The United States people have lately put an extensive plant in the post-office portion of the government buildings here; and, by the way, despite the defeat of the Republican party in November, these seem to burn just the same under a Democratic administration. The same company are wiring large plants in the Home, the Northwestern, and the Royal Insurance buildings, the Mahler building and the barber shops of the Palmer House. In these several plants there is a total of about 4,270 glow lamps. The Edison people too are full of work, wiring the new Board of Trade building, adding to the Pullman building plant, and the county buildings at Wauwatosa, near Milwaukee, and will soon be wiring the city buildings and the two tunnels from the south division to the west and north divisions of the city. This latter plant will consist of two engines and four generators which will be placed in the basement of the city buildings, with a capacity for 1,500 lamps of 16 c. p. Of these about 300 will be distributed between the tunnels, the remainder in the corridors and various offices of the city building. It is proposed to light only a portion—about one-third—of the tunnel lamps during daylight, the entire number

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being in use at night, while an average of three hours per diem will be the use of those in the building. Advertisements for bids were published early in the past winter, and the Edison company made proposals for furnishing the plant in accordance with the above data, for $41,375, and the council at the regular meeting of the 30th of March, ordered,

"That the Controller is hereby directed to enter into a contract with the Western Edison company, in accordance with the proposition of the said company, dated Dec. 26, 1884, in regard to lighting the buildings of the city, for the sum of $41,375."

The city officials, whose duties require artificial light to a greater or less extent, are as tickled as a boy with a new top, at the approaching release from the thraldom of gas. As one of these remarked to the writer, "This light is like fresh eggs compared to the kind that are only fit for scrambling, when placed alongside of gas. A gas plant is a bad egg all the year round—a bad color, pollutes the air, and——smells."

Then again McVicker's theatre is to be lighted with incandescent lights. So too the new Chicago Opera House; and the present Grand Opera House has lately blazed up with glow lights. This last is a Mather-dynamo-Perkins-lamp plant, and makes a very pretty showing indeed. A stage trick accompanied its inauguration. On the night of its debut, the auditorium was lighted up as usual with gas jets. All being ready these were extinguished, and electric lights substituted. The audience, at first astonished and bewildered, then pleased, saw the joke, and broke into the most uproarious applause, indicative of their approbation. The management look upon it as a grand and complete success, and it was the more acceptable, as it was not expected save by the minority.

When the plants mentioned shall have all been completed, Chicago will have nearly all her finer places of amusement lighted by this force which cheers but never vitiates, to wit: Columbia (*nee* Haverly's), McVicker's, New Chicago, The Grand, The Academy theatres, while arc lights hang before or within the Standard, the People's, Hooley's, several of the museums, and most of the better skating rinks, and the panoramas of Gettysburg and Siege of Paris.

Chicago doesn't propose losing her place in the procession in another direction. As she was foremost in the grip car enterprise, and prefers to lead rather than follow like a slow coach, *that* is beginning to be thought old fogyish, and it is now suggested that something better must take its place. So parties have come to the front with a proposition to give us an electric railway. The proposed route is from Adams, on State street, along this latter street to 63d, with a lateral branch on 43d from State street to the Stock-yards. The company proposes to pay for the right of way over this distance, which is something more than eight miles, $10, $5, and $2, per foot, according to locality, to owners of property along the route. Petitions are being circulated, the statutes requiring the consent of a majority of land owners, before any further steps can be taken, and it is believed that the proposition will be accepted by those most interested. The company is pledged to warm their cars, which will be a great point gained, if we are hereafter to experience such weather as was furnished by the signal service last winter, and further, the cars are to be electrically run, above the street grade, so as not to interfere with road traffic proper. Once this sort of transportation succeeds here, schemes for elevated roads will be as plenty as slivers in a lumber yard, throughout the city, and enough horse car stock, rails, cars, etc., will be for sale to supply any number of new settlements throughout the West cheap. If consent is obtained, the present enterprise will be in operation by next winter.

Attention has repeatedly in these columns been called to the fact, that very many of the underground systems in vogue, are faulty in that they are leaky not only to water, but to sewer and burning gas as well. Chemistry tells us that ordinary burning gas, when mixed with atmospheric air is highly explosive and dangerous when ignited. In other places besides Chicago this fact has been practically proven a sufficient number of times to hint at the necessity of doing better work in that line. The last practical joke of the burning gas factor here was played upon Charley Summers, the electrician of the Western Union, and Mr. A. Brotherhood, the company's engineer, who came near being seriously, if not fatally injured by an explosion of this nature from one of their underground conduits. On the heels of this, and by way of variety, Mr. W. C. Hopkins, superintendent of construction for the Postal company came near losing his life from sewer gas, while on a round of inspection, at one of these equally philosophically arranged death-traps.

Prof. Barrett has come to the front with another improvement in our already excellent fire alarm system. Heretofore, at any night alarm, all the fire department were roused from their beds, and stood ready to turn out, regardless of the locality whence the alarm came. Now, as a majority of all the engines and other apparatus is not needed at any one fire, to be routed out, in some instances, several times between taps and reveille was a hardship to which the kind-hearted professor had given much thought. The result of all this cogitation has been the introduction of a switch in the houses, which, when the men turn in at night is thrown over, cutting out all the alarm bells, clothes ropes, apparatus, etc., leaving the register alone in circuit. The man on watch knows by the box number, whether that particular company is wanted. If not, the men sleep in peace, but if they are, he turns the switch, and all hands are automatically called, as before. The result is highly satisfactory, for every man knows now, when called, that he is wanted, and they "govern themselves accordingly," as President Morrison remarked before the late convention here. But the horses, who seem never to sleep, show by their nervousness, although they are locked in, that they understand the call, and evidently wonder why they are not allowed a chance to race for the wagon pole.

The Baltimore and Ohio folks are plowing through Lasalle street with an underground system, the first of its kind here, which consists of a plank trough, about eight inches wide, and four deep, open at the top, which is laid at the bottom of a trench. Into this is poured asphalt and sand, a sort of fine concrete bed. Upon this is laid three two inch wrought iron pipes, which will receive Patterson, Clark and kerite cables. Over these pipes to the level of the sides of the trough, hot asphaltum is poured, and the pipes are thus protected from oxidation, and any minute leaks there may be, are effectually closed. Neither sewer nor burning gas it is claimed can reach the pipes, and water is thoroughly prevented from reaching them. Now, if condensed moisture will let the internal arrangements alone, it looks as if this should be a very nice sort of conduit. Time will show—and nothing but time is a proper insulation test, we all know.

E. B. Purcell, of Manhattan, P. I. Bonebrake, J. R. Mulvane, Joab Mulvane, and N. L. Gage, of Topeka, Kansas, have organized a company for the construction of a telegraph line from Topeka to the Pacific coast, at San Francisco. J. R Mulvane is the president, and P. I. Bonebrake secretary of the organization, which is said to be on a sound financial basis, and to have all the business vim and other qualifications to insure its success. When the sequel is reached it will probably show that this is a connecting link in some one of the many rivals of the pugnacious Ancient and Honorable company, whose initials were once interpreted to mean *W*-hip *U*-*Too*-*C*-ully.

Telephone matters are as quiet as owls at noon. The Central Union has declared its 5th dividend, of 1½ % payable on the 25th, and its stocks are a shade better therefor. Should the promised continuance of these quarterly dividends materialize there is no doubt the stock will reach par once more. Everything is reported in good shape, and prospects bright for the future, and there really seems no reason why such a state of things should not continue.

The Wisconsin company comes to the scratch every ninety days, and pays its quarterly 2 % ten days after the close of the quarter. This sort of thing has become chronic up there, and stockholders don't care a continental whether notice of dividend reaches them or not—they can always bet the check will, when the day comes.

A little episode in electric lighting, which came to my notice a few days since, deserves to be displayed as a cautionary signal for the benefit of the fraternity. In a large manufacturing establishment in this city, goodly quantities of galvanized iron wire are used, and the storage room for this has been in a dry basement, directly under an arc lamp in near proximity to the dynamo, in the same room. On the occasion referred to, the dynamo was running, and the lamp for some reason refused to burn. The party in charge, mounted the pile of wire, which consisted of many tons, and immediately upon touching the frame, received a decidedly sharp shock. The insulation of the circuit at the time exceeded the required limit, 1 megohm, and the only explanation of the phenomenon which seems to answer the requirements of the question is that the wire assumed the role of condenser and charged through his body. If this theory is correct, additional precaution should be observed in handling live circuits in close proximity to insulated columns, pipes, frames of metal, etc., for an accidental contact with one of these while handling a lamp or carbon might prove harmful if not fatal. Perspiring hands, damp feet or clothing are often quite an important matter, materially affecting the conductivity of a derived circuit, and the closer one who has charge of a dynamo circuit sticks to what has been sometimes stigmatized as "granny's rule," of "one hand in your pocket and think twice before you touch it," the better for him.

CHICAGO, April 15, 1885.

BOSTON.

More Objections to Increasing the Bell Telephone Capital.—Legislative Examination of the Books.—Discrimination against Telephone Subscribers.—Mr. McAdie on Atmospheric Electricity.—A Life Saved by Overhead Wires.—An Attempt to Prevent Telegraphic Errors by Law.—Electrical Photography in a Theatre.—The Martin Automatic Fire-Alarm System.—The Boston Telephone Exchange.

A MEETING of New England and Erie Telephone stockholders was held on the evening of March 23d in Lowell, the object of

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which was to send a representation to appear before the legislature to remonstrate against the petition of the American Bell Telephone Co. for permission to increase its stock. A committee was appointed to go before the legislature and present the remonstrance. The chairman of the meeting was E. Lamson, and L. S. Adams was secretary. The Mr. Lilley who has been so conspicuous before the state committee was present at this meeting, and informed those present of the status of the matter.

The sub-committee from the legislature has been examining the books of the Bell company, who answered many of the questions proposed under protest.

The committee on mercantile affairs has agreed upon the following bill to prevent discrimination by telephone companies:—

SEC. 1. Any person or corporation owning, controlling or operating a telephone exchange or service in this commonwealth shall, on application of any telegraph company, furnish the telegraph company so applying with the use of a telephone or telepnones and telephone service and connection with their respective exchanges, and the subscribers thereto without discrimination between telegraph companies as to such connection, service or use of instruments furnished or charges therefor.

SEC. 2. Any person or corporation using, controlling or operating a telephone exchange or service in this commonwealth shall, on application of any individual or corporation and the tender of the charges or rental sum usual or customary for the class of service required, without unreasonable discrimination for the same class of service rendered, furnish such individual or corporation so applying with the use of a telephone and telephone service and connection with their respective exchanges and the subscribers thereto, provided that the individual or corporation applying will secure the rights necessary to make the connections applied for, and pay to the telephone company in advance a sufficient sum to cover the actual cost of the extension, if said extension is beyond one mile from any main exchange circuit of the said telephone company applied to.

SEC. 3. Any court in the commonwealth having equity jurisdiction shall, upon petition of any party in interest, enforce the provisions of this act by any suitable process or decree in equity.

SEC. 4. This act shall take effect upon its passage.

April 7th the committee had another hearing in the matter of supervision and regulation of telephone matters, Col. J. H. Benton for the petitioners and Geo. A. Bruce for the Bell Telephone company. Col. Benton made an argument and cited decisions to show that the state had the power to do what the petitioners asked for. Mr. Bruce preferred to postpone his reply until the committee considers the matter of direc ly fixing telephone charges

Mr. Alex. McAdie, of the U. S. Signal Service, spoke before the Boston Scientific Society, March 10th, on "Atmospheric Electricity." The speaker asked what proof there is of atmospheric electricity, and answered himself as follows:—1st. We have the aurora and its manifestations similar to passing electricity through rarefied air. 2d. The auroral energy acts on ferruginous matter like an electric current; telegraph lines and all forms of electrical apparatus are affected. 3d. If this energy encounters resistance it is converted either into heat or light. 4th. Certain bodies, like sulphate of quinine, will fluoresce under its action. The effect of atmospheric electricity on dust or haze was shown by an experiment of Dr. Lodge. An inverted goblet was filled with smoke; a current being sent through, the air rapidly cleared. This is supposed to explain the so-called clearing of the air by a thunderstorm. Lord Rayleigh's experiment of influencing the lines of flow and character of a fine stream of water was then shown. A piece of electrified sealing-wax being held near a thin stream of falling water, it was visibly deflected. Rayleigh conducted the experiment on a much larger scale, and although his piece of sealing-wax was seven or eight inches from the water, yet it was found to be covered with a film of moisture. This experiment affords an explanation of the rapid growth of a thunder cloud. The cloud acting in a similar manner to the sealing-wax, attracts the particles of water in the air.

Let us score one, and a good one, for overhead wires. At the severe and stubborn fire in Boston, March 24th, while Chief Webber, of the fire department, was directing the work of the firemen on the roof of an adjoining building, he tripped and plunged headlong, and but for his fortunate grasp of a telephone wire he encountered on his way down to the street, he would undoubtedly have been instantly killed.

Mr. Dunbar, for the legislative committee on the judiciary, reported a bill to secure greater care in the transmission of telegraphic messages. The bill provides that all persons, associations and corporations engaged in the business of transmitting or receiving telegraphic messages for hire shall be liable and responsible for all damages caused by their negligence, or that of their servants or agents in transmitting, receiving or delivering such messages, notwithstanding any contracts, written or oral, to the contrary.

The stockholders of the New England Telephone & Telegraph Co. have received notice of the annual meeting, to be held at the company's office, 144 Greenwich street, New York, May 4, 1885. The transfer books of the company are closed from April 4 to May 4, 1885.

The Suburban Telephone Co. has declared a dividend of 2½ per cent. This is the dividend announced in January as likely to be paid in April. The money is derived from the payment of a loan to the Erie Telephone Co.

At the Bijou theatre, April 10th, a scene not down on the bills took place. At the close of the first act, Mr. H. B. Lonsdale announced to the assembly that a photograph of the house would be made, and after three attempts a successful negative was obtained. Mr. Conly was the photographer. All of the Edison lamps ordinarily used were supplemented by 15 of the American company's, the whole illuminating power being estimated as 40,000 candles.

The Martin Automatic Fire-Alarm Co. have recently introduced their system throughout the immense establishment of Jordan, Marsh & Co. The committee on tariff rates of the Boston Tariff Association voted to make a reduction in the rates of insurance of 15 per cent. of the gross insurance premium paid by Jordan, Marsh & Co., on account of the introduction of the Martin system. It possesses many features of novelty. It gives instant notice of all disturbances and accidents to itself, indicating by separate and distinct signals the character of the interruption, a broken wire, a weak battery or a ground, so that the apparatus may be repaired at once. It also gives a distinct and separate alarm for a fire, or any undue heat in any part of the building protected.

The Boston Telephone Exchange people are now using the new multiple board system very successfully. Mr. Theo. N. Vail, general manager of the Bell company, has made the operating room of the exchange very attractive by placing therein a high semicircular stand for flowers, and filling the same with a choice selection of plants, some of which are in bloom most of the time.

BOSTON, April 18, 1885.

NEW ORLEANS.

The Exhibition Adopts a Half-Rate System.—Where the Finest Night View May be Had.—Electrical Hotel Fittings.—The Contract for City Lighting.—Proposal to Light the City for a Term of Years.—Arrival of the Baltimore and Ohio.—Progress of the Opposition Telephone Company.

SINCE the first of April the admission to the Exposition after five o'clock P. M. has been reduced to twenty-five cents, and as a consequence there are now more evening visitors than of old. However, it would require the number to be still vastly increased to justify the great outlay that has been made in electric lighting.

The finest view of the buildings and grounds, at night, is to be had from the upper deck of a steamboat out in the river. Visitors who failed to obtain that view certainly have missed a most enchanting scene.

This city must have been looked upon as a "mine," by electric companies of all kinds, this winter, and they have "worked" it with a will. New hotels of all sizes and styles have required bell outfits. The great Exposition hotels—"The Windsor" and Hotel Royal were fitted up by the Western Electric Co. Hotel Royal has a very unique light plant consisting of a 300-light Edison machine and a 16-light Jenney dynamo, both driven by an Armington-Sims engine. The St. Charles Hotel is equipped with a 150-light Edison dynamo, furnishing lamps to the rotunda, halls, parlors and offices on the first floor. This is the third season of this installation, however. The Jenney company has also sold to the "Battle of Sedan" a plant of 30 lamps and a dynamo, which has successfully illuminated the panorama since its opening to the public some four months or so ago. The steamboat R. L. Cobb was likewise fitted with four lamps and a head-light by this company.

Notwithstanding the lower bid of the Brush company, the city contract mentioned in my last letter has been closed and signed with the Louisiana company and the matter settled. One of the reasons given by the Mayor for signing the bill, was that it would encourage competition—but the Brush people call such measures, "*dis*-couraging competition." The Louisiana company is going right ahead with the work, as per contract—60 days is the time allowed in which to have everything in readiness. The New York Safety Steam Power Co. will not furnish the motive power for this plant, as it would not agree to the terms of the company. The Bass Iron Foundry of Fort Wayne will put up five 75 h. p. engines and boilers complete, and the Jenney company furnish ten dynamos of 30 lamps capacity each. In selecting their site, the Louisiana company has obtained ample space for any ordinary increase in business which will necessitate the enlargement of the plant. As yet the city fathers have not agreed among themselves as to the number and location of the towers and poles.

The Brush company has just offered to extend its field of usefulness by putting up 15 lamps on arms upon a street hitherto lighted by gas. This it offers to do for the sum of $180 per month.

Lighting companies in general had better keep their eyes open next month (May), as a city ordinance is being prepared which provides that the Mayor shall advertise for bids for lighting the city with gas or electricity for a period of years from January 1, 1886. Bids are to be received in May, and the contract awarded the 1st of June, thus giving the successful company ample time to have everything ready for a trial of the lights December 1st. All details necessary regarding the quality of the

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lights and the ground to be covered will be inserted in the advertisement, and the same sent to all lighting companies in the country.

Since my last writing, the lines of the Baltimore & Ohio Telegraph Co. have reached the city, and an office opened for business. Starting with rates greatly lower than those of the Western Union, the company has been favorably received, and as much business has been presented as could be expected. Call-boxes will be placed throughout the heart of the city, and patrons furnished with messengers to receive their despatches. This company claims to be the first to introduce any opposition to the Western Union in the state of Texas, where it has already established many offices. It will also extend its lines largely during the summer in the Southern and Eastern states. In this city the business of the company is in the hands of Mr. E. Leloup, superintendent, and Mr. Robt. Ewing, chief operator. Rates of the Western Union have been reduced to all competing points to the same figures as those of the B. & O.

The Crescent City Telephone Co. put up its three hundredth pole yesterday and still the work goes bravely on. The $5 pole tax, I am told, it pays as it goes along, without any kicking. Mr. T. J. Perrin is at work putting up one of his multiple switchboards in the exchange, which he expects to complete and have ready for business before May 1. Some 70 instruments are already out, but only in the offices of some of the stockholders and their friends. A hundred of the improved instruments, working with a battery instead of a magneto-call, are ready and will be put out at once. Charges have not yet been decided on, but it is asserted that they will be greatly lower than the present Bell rates. In fact, the Crescent City admit there is room for but one company in this city, and if it can furnish a better service at less cost than has heretofore been enjoyed, it will take from the Great Southern all its subscribers,—if it can not do this, it will have to pull up stakes itself. A case of the "survival of the fittest" it appears to be, and time alone will determine the identity of that same.

New Orleans, April 16, 1885.

SAN FRANCISCO.

Electric Motor Agents on the Ground.—Arizona Taking the Lead in Business.—The Baltimore and Ohio Looking Over the Ground.—District Telegraph Competition Detrimental.—Rumored Salary Reduction.

The arrival in this city of several agents of electric motors applicable to railway purposes, should be convincing proof that your columns have directed attention to the favorable opportunity awaiting their introduction in this city. I wonder if the successful competitor will remember your journal in consideration of the "pointer" contained in my February letter.

Nevada is practically dead, and it would require "the last trump" to awaken it to its former activity; but Arizona is beginning to loom up, and promises to supersede Nevada in mineral wealth. So far Arizona has 50 telephone exchanges and 43 electric lights. This includes the territorial prison at Yuma which has three mast lights, and the agents are sanguine of doubling this number in a few months. San Diego, California, is agitating the subject of having that town lighted by the mast system of electric lighting, the same as is so successfully and satisfactorily operated in Los Angeles. Within the last two years the growth of southern California has been remarkably great, and the business which Sacramento and Marysville had a monopoly of, formerly, is now directed southward, which promises to be a better field. In the towns of Los Angeles, San Bernardino, Santa Barbara and San Diego there are in operation 375 telephones and 300 electric lights, this is indeed a good showing and much more encouraging than twice as many in older cities.

R. R. Haines is the pioneer telegraphist of southern California and Arizona; he is now manager for the Western Union at Los Angeles, where he also edits a temperance journal, of which cause he is a great advocate, hence you will observe R. R. does not stand for "Rum, Romanism." Uncle Rufus, as we call the venerable patriarch, was once an editor in the historic region of Cape Cod, Mass. To Mr. J. C. Sherer, also, much is due for the success and introduction of electricity in its various forms in southern California, and it must be indeed picturesque to pick oranges from the branches under the glare of electric lights.

Mr. James Gamble is busy. He has great speculations in his eye, and to some in his confidence he intimates that he will have all the towns from Seattle on the Sound, to San Diego in the south, connected with San Francisco before the people will realize that it can be done.

S. Spencer, vice president of the Baltimore and Ohio Railroad Co. is doing our state in a special car with some friends. It is reported that he has had several meetings with Mr. Gamble, and that arrangements will soon be consummated for the extension of the B. & O. telegraph to this coast. The lines of that company are already operated to Fort Worth in Texas, which is only about 1,200 miles from the southern boundary of California. A through line by the southern route would be much more reliable in the winter season, not being liable to interruption from snow and sleet, besides which it would secure the Arizona business, which is much better now than that of Nevada and Utah by the old route.

Mr. Spencer visited the Western Union office a few days ago to send some messages, and he signed them in his official capacity "Vice-pres't Balto. & Ohio R. R. Co." The receiver thought of course he held a frank, and asked him to show it, instead of which he handed out a gold piece which elicited the remark from the veteran receiver, "Well, you are the first vice-president of a railway that has paid me for a message in a long time." Mr. Spencer was evidently pleased and said, "we may have a rival line of our own here yet, and then I may satisfy you with D. H's."

The District rivalry still goes on. Mr. Gill, of the San Francisco company says he has the American District literally "knocked out," whilst the manager of the latter says its only a question of a few weeks before the San Francisco company will be compelled to sell out. To a man up a tree, however, it would appear that there is a good deal of buncombe and unnecessary expense resorted to. Honest rivalry is commendable. Quick, intelligent service is what the public wants and is willing to pay for.

I have seen the District system in '75 and '76, when there was no competition, give better service and more satisfaction at a much less cost, although the boys were then paid double what they are now. The same can be done again by both companies and with much more profit. The money expended by solicitors drumming up patronage, had better be distributed among deserving boys, who when encouraged are more efficacious drummers by their good work than all the loud talkers from Cape Cod to Goat Island.

The air is murky with rumors of reduction of salaries, to take place after to-day. As yet we have received no official notice thereof, and it is time enough to "Bid the devil good morrow when we meet him" than to go out of our way to do so. If it will result in weeding the force of its best men, the same as the increased hours has done in Ogden, Utah, it is to be hoped it will not become a law. It is "catch as catch can" in Ogden, anything that can telegraph is put down to the overland wires, and as a result that business is mercilessly butchered, and when a "respectfully referred" in due course arrives, the good man who has grown grey on that circuit is made to pay for it and Mr. Plug is allowed to escape the penalty.

This looks like a premium on incompetency. With the exception of those who are anchored by family ties, a good man will not be found in Ogden ere long.

San Francisco, Cal., March 31, 1885.

WASHINGTON.

The Senate Committee Favors the Electric Light.—The United States Electric Light Co. Outgrows Its Quarters.—An Electric Light Superintendent Selling the Company's Property.—The Patent Office Changes.—Completion of the Baltimore & Ohio Building.

The report of the Senate committee on public buildings and grounds, which, it was expected, would be made before the adjournment of the 48th Congress, so that an appropriation could be made to carry out the plan recommended during the then approaching recess, was not made until just before the close of the executive session. At that time no money, save from the Senate contingent fund, could be appropriated, the House not being in session. The committee starts out with the plump declaration that the electric process "is a safer, cheaper and more salutary light than any of artificial production, avoiding the heat and vitiated air resulting from the use of gas, to which is to be ascribed, in some measure, it is believed, the impure atmosphere of the chamber; but, out of abundant caution, the committee advise that further experience with and opportunity be allowed to observe the performances of this light before the substitution shall be made." It will be observed that the committee adopt the popular idea of "the impure air of the chamber," when, as a matter of fact, every sanitary engineer or chemist who has investigated the subject has pronounced it exceptionally pure, save in the corridors and cloak rooms. The air is carried entirely outside the building after coming in contact with the gas-lights which light the chamber, without a possibility of its return to the floor or galleries.

The estimated cost of the plant for lighting by the Edison incandescent system is given in round numbers at $15,000. The cost of continuously running 800 lamps, including interest on the plant, is put at 0.35 cents per lamp per hour, and an equal number of gas-lights at 0.9 cents per hour. Taking into consideration the irregular times at which the lights are required for the Senate, the estimate of cost is considerably advanced, and after a series of computations the estimate is reached of 0.88 cents per light per hour for the Edison, 16 c. p. lamp, and 01.15 per hour for a gaslight of equal brilliancy.

The committee, under the circumstances of the case, have authorized the superintending architect of the capitol, with the advice and approval of its chairman, to make such further

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arrangements as may be desirable for continuing the test of this light by the Edison or other like system at reasonable and proper cost.

The United States Electric Light Co. has run itself up to the capacity of its original plant. The maximum of power and space has been reached, and at a meeting of the stockholders on Monday the directors were authorized to find a suitable location, and establish a new station of much greater capacity than the present one, and sufficient to meet any reasonably prospective demand in the near future. A variety of questions were left to the determination of the board, such as whether the funds for the extension should be raised by new stock or first mortgage bonds, and certain negotiations with the district authorities for concessions as to the running of wires, etc. Conclusions have not yet been reached by the board.

The Brush-Swan company seems to be doing but little in the way of practical work. Its late superintendent, B. M. Reed, however, appears to have done a thriving business for a while on his own account. Being left in charge of the company's warehouse, he negotiated with an Alexandria house for the sale of several hundred dollars' worth of copper wire. There was some difference about the price, but Reed finally wrote them that "the company accepted their offer," and delivered the wire in open day. He then reported that the wire had been stolen, and entered heartily into the efforts that were made to discover the thief and regain possession of the wire, even visiting Baltimore (at the company's expense) to trace up a clew that he claimed to have. Other detectives were more successful, and the wire was found in Alexandria. Reed, on being arrested, confessed his little scheme, and was held for trial. He hails, I believe, from some place in Ohio

The selection of Mr. Montgomery to fill the position of Commissioner of Patents, is regarded as one of the best of President Cleveland's many good selections. It is understood to be a personal selection made from a thorough knowledge of Mr. Montgomery's adaptability for the place, acquired as a member of the Buffalo law firm, and to have been heartily approved by President Cleveland's associates in that firm.

Gen. Vance, made assistant commissioner, was a strongly backed aspirant for the first place. He is a man of the strictest integrity and untiring industry. His fault if any would be that he strove too completely to master the details of everything coming before him for action. Major Dyrenforth, late assistant commissioner, and who was also endorsed by men of both parties, including it is said "Senator" Lamar, and whose displacement was made necessary for the appointment of Mr. Vance, goes out of office with many warm friends and many bitter enemies. He proposes to practice in this city as a patent attorney.

The subject of a postal telegraph has probably not been thought of as an administration measure, and if anything is done in that direction during the next four years the action will have its inception in one or the other branches of Congress The rates have been so reduced by ruinous competition, that for the government to enter the field now would leave it with a large balance on the wrong side of the ledger at the close of the fiscal year.

The Baltimore and Ohio company has gone one step further in cutting rates, and now is selling books of stamps with a face value of $11.20 for ten dollars. Carrying the idea on to a logical conclusion one of their larger customers sought to buy eleven books for an even hundred dollars. The offer was forwarded to headquarters, and a reply is awaited.

After encountering numerous obstacles and delays, this company has finally seen the completion of its new railroad and telegraph office building which is pronounced one of the most convenient and elegant structures of its character in the country. It is located on the site for so many years occupied by the Western Union company, corner Pennsylvania avenue and Fourteenth st., the best and most central point for telegraph business in Washington.

WASHINGTON, April 23, 1885.

ELECTRICAL NEWS AND NOTES.

THE PRINTING TELEGRAPH SUIT DECISION OF THE COURT.

In the Circuit Court of the United States for the Southern District of New York, the following decision was rendered on April 1, 1885, in the action of the Gold and Stock Telegraph Co. *vs.* the Commercial Telegram Co. *et al.*

SHIPMAN, *J.*:

This is a bill in equity to restrain the defendants from the infringement of reissued letters patent No. 3,810, granted to the plaintiff, as assignee of Edward A. Calahan, January 25, 1870, for an improvement in telegraphic printing instruments for registering the prices of gold and stocks. The original patent was dated April 21, 1868.

Upon the trial of the case, infringement of the second claim only of the reissue was alleged. The claim is in these words:

> Two or more type-wheels moving independently and controlled by magnetism, and arranged so as to print jointly or separately upon one strip of paper in two or more lines, substantially as specified.

To understand and construe the claim which is in controversy, it is important to know the state of the art at the date of the invention. In this case, the defendants took no testimony and therefore the history of the art, so far as it relates to this claim, is to be learned from the reference which was made to it in the cross examination and subsequent examination of the plaintiff's expert. The Theiler, French, and the Johnson, English patent for the Theiler invention, which seems to be conceded to have embodied the state of the art at the time of the Calahan invention, are not in evidence, but a general statement, and one which will be sufficient, can be given of the extent of the evidence which Calahan made.

Theiler had a two-wheel instrument, the wheels being moved by one electro-magnet and being geared together and necessarily rotating together. Letters were placed upon one wheel and figures were placed upon the other, and the letters were printed upon one line and the figures were printed upon another line of the same tape by depressing the corresponding type-wheel. But it was necessary to have complicated mechanism so as to prevent impressions from one wheel when the other alone was being printed from.

Calahan printed letters in one line and figures in another line of a tape, by the aid of two type-wheels, one of which could be rotated to the exclusion of the other, and a single press pad. His wheels moved or rotated independently of each other, while in the Theiler machine, one wheel could not be moved without rotating the other.

He says, in his specification, that his invention was intended, among other things, to dispense with the complicated mechanism theretofore made use of to cause an impression to be made when the type-wheel had been brought to a proper position, and describes his device as follows:

> A magnet and armature are employed in effecting the movement of the type-wheel, so that the same is turned to the required position, and then by an independent motion, separately controlled from that of the type-wheel, the impression is made, so that the type-wheel can remain after it is adjusted or be again moved previous to the impression being made. The impression is made on a strip of paper by two type wheels, so that the printing is in two lines, and the figures and fractions for denoting the prices or quotations are contained upon a wheel and combined therewith. Letters are provided for printing on the same strip of paper to denote the article to which the quotations relate. As the different machines will generally be but a short distance apart, it is preferred to make use of two or more wires communicating through the entire circuit of machines. One of these wires transmits the pulsations of electricity that act upon a magnet and adjust the type-wheel to the proper letter or number. The other wire transmits the pulsations of electricity, which, acting in a magnet, produce the impression upon the paper. In the drawings, three circuit wires are represented, one for the alphabet wheel, another for the number or figure-wheel, and the third for giving the impression; but the number of wires employed is unlimited. * * * * *. The two type-wheels, *k* and *l*, although on separate shafts, stand contiguous to each other, so as to be impressed separately or jointly upon the same strip of paper that is fed along beneath them, the impression from the respective wheels forming two different lines of printing. * * * *. Each of the wheels, *l* and *k*, has a blank space that is turned toward the paper while the other wheel only is being printed from.

This blank space prevents the wheel which, for the time being, it is not desired to print from, from making impressions on the paper.

The independent rotation of the type-wheels, as distinguished from type-wheels which must continuously and necessarily rotate together, is the principal feature of the invention of the second claim, and it is not a prerequisite to this independence of rotation that each wheel should be under the control of its own independent magnet. This is a feature of the Calahan machine, but it is not a part of the second claim.

The claim requires that each type-wheel shall move or rotate by magnetic action, independently of the other and that it shall not be necessary to the movement of one that the other should, at the same time, be rotated also, and that a strip of paper and one impression pad shall be moved up against the type-wheels by a magnet, so that impressions from the character upon either or both wheels may be made upon the strip of paper and thus a message may be printed exclusively from one wheel or may be printed in two lines from the characters on both wheels, that is, by the united or joint action of both wheels, but it is not a requisite that this printing shall be done simultaneously.

The great contest in this case was in regard to the meaning of the word "jointly," the defendants insisting that it meant simultaneously, and the plaintiff insisting that it meant, by united action, or acting in co-operation, and thus, that when there was occasion to use both letters and figures upon a single strip, as is usually the case in transmitting stock quotations, such printing could be done in two lines by the united or joint action of the two wheels.

The latter is, in my opinion, the correct interpretation of the claim for three reasons:

1st. The improvement or the advance in the art did not in fact consist in simultaneous printing. It did not remedy the existing evil and was not the thing which the patentee apparently wanted to accomplish.

2d. The patent does not mention simultaneous printing as a thing which the instrument was necessarily to do; it points out that the wheels were so arranged with reference to each other

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that they could be used on one strip of paper jointly or separately, that is, either or both could be used to make one message, and when both were used, the impression from the respective wheels formed different lines. The idea which the specification and the claim convey, is that the operator can use both wheels and so a double-line message can be produced by their joint action, but there was no requirement that they must be used simultaneously.

3d. While the Calahan instrument, before a unison device was added to it, had the capacity of simultaneous printing, such printing is not and was not supposed to be of practical value.

The defendants', or the Field instrument, has two wheels, one, a figure wheel, and the other a letter wheel, on separate shafts both controlled by magnetism and each moving independently. The wheels print by their united action in two lines upon one strip of paper moved up by a press-pad, and can print by the use of either wheel separately. As in the Calahan machine, both wheels are provided with a blank space which is turned towards the paper while the other wheel is being used to print from.

The difference between the machine of the Calahan patent and the Field machine is that the latter has a device by which, after a wheel has ceased to print, it returns automatically to the zero point and is locked there before the other wheel can be rotated. In the opinion of the defendants, their machine is relieved from the charge of infringement, because the wheels do not move independently and cannot print simultaneously. The latter suggestion is disposed of by the conclusion that the claim does not require such printing. The defendants say that their wheels do not move independently, because it is a "condition of the rotation of one wheel that the other shall first be brought to a state of rest." This does not prevent independence of motion in the sense in which Calahan used the term independent. One wheel is not linked to the other, so that both must rotate together, which is what he desired to avoid. Either wheel is rotated without thereby rotating or moving the other, a result which he desired to gain.

So far as is disclosed by the record, the allegation of infringement is sustained.

The next point is in regard to the duration of the Calahan patent, the defendants insisting that no injunction can issue, because the patent expired on March 16, 1885.

William Edward Newton received, upon a communication from Elisha W. Andrews and Edward A. Calahan, an English patent for the Calahan invention, which was sealed on August 21, 1868, and dated March 16, 1868, the day on which the provisional specification, with the petition of Newton, was filed at the office of the Commissioner of Patents. The original United States patent to Calahan was dated April 21, 1868, and from the copy of the original patent, which is in evidence, it appears that the application must have been made as early as December 28, 1867.

The effect of the 16th section of the act of March 2, 1861, taken in connection with § 6 of the Act of March 3, 1839, upon the duration of the United States patents for an invention which had been previously patented abroad, has been frequently discussed. (*De Florez* v. *Reynolds*, 17 Blatch., C. C. R., 436.) But I am not aware that it has been supposed that the 6th section of the act of 1839 related to patents which were issued by the United States before an English patent had been sealed and published. In this case the English patent was sealed five months after the patent in suit was issued, and although the English patent was, when published, dated March 16, 1868, I do not suppose that such date has an effect upon the life of the subsequently issued United States patent.

It will also be noticed that the application for the United States patent was made before the provisional specification was filed in the office of the English Commissioner of Patents. The decision of Judges Grier and Kane in *French* v. *Rogers*, 1 Fish., 133, in 1851, was to the effect that a United States patent issued after the issue of the English patent, but applied for before the date of the application for the English patent, was not within the 6th section of the act of 1839. This point was left undecided by the Supreme Court in *O'Reilly* v. *Morse*, 15 How , 62, decided in 1853.

The second claim of the original Calahan patent was as follows:

> Two or more type wheels separately controlled by magnetism, and arranged side by side, or with their axis on the same line, so as to be impressed jointly or separately on one strip of paper, substantially as and for the purposes set forth.

The second claim of the reissue does not enlarge the original claim: it is a more exact and more clearly defined statement of the invention than the original patent contained, but the original claim would probably have received the same construction.

There should be a decree for an injunction and an accounting. The terms of the decree will be settled upon hearing.

THE DECREE.

At a stated term of the Circuit Court of the United States, in and for the Southern District of New York, held in New York on the 6th of April, 1885, Judge Shipman issued the following decree:

This cause came on to be heard at the February Term, 1885, of said court, and was argued by counsel for the respective parties, and thereupon, and upon consideration thereof, it is found and hereby ordered, adjudged and decreed, that the reissued letters patent, upon which this suit is brought, to wit, letters patent granted to the Gold and Stock Telegraph Co. as assignee of E. A. Calahan, dated January 25, 1870, and numbered No. 3,810, are good and valid in law. That the said E. A. Calahan was the original and first inventor of the invention described in said reissued letters patent No. 3,810; that the title thereto, and to the invention described and claimed therein, is vested in the complainant, and that the defendants have infringed the second claim of said reissued letters patent No. 3,810, and the exclusive rights of the complainant under the same.

And it is further ordered, adjudged and decreed that the complainant do recover from the defendants the profits, gains and advantages which the said defendants have received or made, or which have arisen or accrued to them by reason of any infringement by said defendants of the said second claim of said reissued letters patent No. 3,810, since the date thereof, as also the damages which the complainant have sustained by reason of said infringement, to be assessed as provided by statute.

And it is further ordered, adjudged and decreed that the said complainant do recover of the defendant their costs and charges and disbursements in this suit to be taxed.

And it is further ordered, adjudged and decreed that it be referred to John A. Shields, Esq., a master of this court (there being special reasons for his appointment, the same being the agreement of the respective counsel thereto combined with his experience in accounting in patent causes), to ascertain and take, and state and report to the court an account of the gains, profits and advantages which the said defendants have received, or which have arisen or accrued to them by reason of any infringement by them of the said reissued letters patent by making, using or selling the same since the date of said letters patent, and also to assess the damages suffered by the complainants herein by reason of any infringement by defendants since the date thereof.

And it is further ordered, adjudged and decreed that the complainant on such accounting have the right to cause an examination of the said defendants *ore tenus* or otherwise, and also the production of the books, vouchers and documents of said defendant, and that the said defendants attend for such purpose before said master, from time to time, as said master shall direct.

And it is also further ordered, adjudged and decreed that a perpetual injunction be forthwith issued in this suit against the said defendants, according to the prayer of said bill, said injunction to take effect on Saturday, April 11, A. D. 1885, at ten o'clock in the forenoon, and that public notice to the users of the defendant's instruments of the said injunction shall be given by the United States Marshal for this district, by inserting or causing to be inserted over his official signature in the New York daily *Herald* and New York daily *Times*, on April 8, 1885, a brief announcement of the fact of such injunction and of the time when it will take effect.

All questions in regard to treble damages to be reserved until the coming in of the master's report.

THE ELECTRIC RAILWAY INTERFERENCE.—DECISION OF THE ACTING COMMISSIONER OF PATENTS.

SIEMENS *vs.* FIELD.

Decided March 27, 1885.

ELECTRO-MAGNETIC RAILROADING.

APPEAL from the Examiners-in-Chief.

Application of Ernest W. Siemens, filed May 12, 1880.

Application of Stephen D. Field, filed March 10, 1880.

Mr. C. S. Whitman, for Siemens.

Mr. F. L. Pope and *Mr. F. W. Whitridge*, for Field.

In the appeal from the decision of the Board of Examiners-in-Chief, there are seven assignments of error, which I will consider *seriatim*.

First, error "in deciding that the caveat of Field shows substantially all that is shown in the issue presented." The two issues referred to arose in applications relating to a system of electro-magnetic railroading in which both the claims cover a combination composed of five elements. Of these elements four in each issue are similar, namely, a stationary dynamo-electric generator, conductors formed wholly or partly of the rails, a wheeled vehicle running on the rails, and an electro-dynamic motor on the vehicle; in the first issue the electrical connection between the generator and the motor is maintained by the wheels of the vehicle, with or without rollers, springs or brushes; and in the second issue, the two poles of the motor are connected with the generator through the two lines of conductors. In the caveat in question are mentioned plainly the generator, the motor, the vehicle, the wheels on one side of the vehicle insulated from their axles, and a supplemental conductor attached to the rails, all of which are to be used "to propel cars along tracks by means of electricity." The invention is not herein set forth in all its de-

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tails, for that is not the office of a caveat; but there are, undoubtedly, contained in it the germs of the invention, as it subsequently took shape in the claims which induced these issues. The object of this caveat was to protect the inventor while perfecting his invention, and, read in the light of his subsequent specification and claims and in the light of the testimony showing the purpose and course of his experiments—as it must be read where doubt exists in regard to the full force of general and confessedly imperfect description—obscurity disappears, and the completed invention stands revealed, though still in embryo.

I, therefore, concur in the opinion of the Board upon this question.

Second, error "in refusing to hold that the conduct of Field, in failing to claim the invention for over two years after he knew of the public use by Siemens, constituted negligence." I find no warrant in the record for the implication herein that Field knew, at any time prior to filing the claims involved in these issues, that Siemens had used the identical combination covered by him. It is true that detailed descriptions of the Siemens electric railway in Berlin, appeared in the public prints in Germany, in July, 1879, but it does not appear that knowledge of them was brought home to Field. It does appear that he read a general description of the railway in the summer of 1879, and talked to various persons about it, but that is all. At that time his caveat was in the office, having been filed May 21, 1879, and, therefore, he was not bound to make claim until the expiration of the year. On March 2, 1880, he renewed his caveat, and on May 10, following, filed his specifications and claims. These specifications described the inventions involved in these issues, though the claims did not cover them, and on May 21, 1881, the claims were accordingly amended. That this amendment was made at the suggestion of this office, it is true; but that suggestion was made because the specifications unmistakably showed and described the combinations in question as part of the invention, and it cannot be denied that the patent law was designed to protect that invention fully. Certainly Field cannot be held to be guilty of negligence prior to March 10, 1880. Subsequent to said date his application was in the hands of this office, undergoing examination preparatory to issue of patent; and, since his specification exhibited these combinations, if patent had issued in July, 1881, without these claims, the courts would have sustained a reissue made on immediate application. If so, I see no room for a charge of negligence between March, 1880, and July, 1881. Hence the allegation of negligence falls to the ground, and the Examiners-in-Chief were right in not finding it.

Third, error "in holding that July 9, 1879, is the earliest date assigned to Siemens as an inventor." Said holding was based on the fact that on July 9, 1879, there appeared in a periodical in Germany, the first complete published description of the Siemens electric railway; and on the rule of this office that a foreign inventor will not be allowed to show a date of invention prior to the date of such a publication. The fact is not disputed, but the contention is that the rule is wrong. Into a discussion of the question I will not enter. It has been the settled rule of the Patent Office since 1846, at least (Tucker *vs.* Davis, II O. G., 224), has had the sanction of the Attorney-General (5 Ops., 18), and has been approved by the Secretary of the Interior (Rumpff *vs.* Kohler, C. D. 1883, p. 111). It is no longer an open question, and the rule should, therefore, be enforced so long as there is no judicial decision to the contrary. Counsel admit that it is "a question which has never been settled by the courts," and, therefore, in my judgment, the Examiners-in-Chief were justified in adhering to the established practice of the office.

Fourth, error "in considering testimony of Field which is inconsistent with the preliminary statement." The facts alleged are that the preliminary statement showed disclosure of the invention on May 10, 1879, and it is urged that "all testimony concerning communications to others (recited below) made prior to May 10, 1879, must be stricken from the record," citing Hopkins *vs.* Le Roy (C. D., 1880, p. 188). Said case decides that a preliminary statement may not be amended after the adverse party has disclosed his case by taking testimony, and is not authority for the above contention. Rule of Practice 105 provides that "the parties (to the interference) will be strictly held in their proofs to the dates set up in their statements." The language of the rule generally admits of but one interpretation, namely, that parties may prove the alleged dates, but no others; and, taken in connection with the object of the provision, as sufficiently disclosed in the case of Hopkins *vs.* Le Roy, it is to be understood as declaring that they shall not prove earlier dates, for the purpose of showing the conception, disclosure or completion of their invention prior to the dates assigned in their preliminary statements. The rule, as thus construed, is amply strict and sufficiently protective of the parties. To extend it to a rejection of all testimony showing an earlier date would be, in view of the infirmity of memory in parties and their witnesses, a hardship, and, in view of the fact that the purpose of the interference is to ascertain priority as claimed, a denial of justice. The only word in the rule of doubtful import is "proofs," and, in my judgment, it should be construed as admitting, as proofs of the date fixed upon, evidence showing the fact alleged on any prior date. To admit such testimony, for such a purpose, is consonant to sound reason, is not oppressive, and is calculated to promote the objects of interference proceedings. If the Examiners-in-Chief considered Field's record showing communications to Ladd in 1870, 1878, and in February, 1879, and to Milliken in 1877, 1878, and in May, 1879, it is evident that they did not find from it the date as earlier than May 10, 1879; and so far as the Examiner of Interferences considered this testimony, it is plain that he restricted it to proof of the date last mentioned. In this view of the case there was no error in the action of either tribunal

Fifth, error "in refusing to consider the drawings of Siemens made in 1878." This falls under the third assignment of error, and the action of the Examiners-in-Chief is deemed proper for the reasons above stated.

Sixth, error "in awarding priority to Field, as his claims, which have been involved in interference, relate to matter which is not described in his specification or shown in his drawings." This question is *res judicata* between the parties. In overruling a motion to suspend the interference and refer the case to the Primary Examiner, Mr. Commissioner Butterworth held on February 9, 1885, that "Field's drawing and specification also appear clearly enough to illustrate and describe the construction involved in the two counts of the issue now objected to." Wherefore, the Examiners-in-Chief properly declined to re-open the question.

Seventh, error "in awarding priority of invention to Field, for that the testimony of Siemens establishes that he (Siemens) was first to discover the dynamo-electric principle of transforming work into current and current into work; first to publish the discovery to the world; first to describe to others the application of this principle to an electric railway; first to make drawings from which a practical railway could be constructed; first to construct and use a practical electrical railway; first to introduce the electric railway into commercial use, and first to apply for a patent." The first two of these reasons seem to be urged in bar of patents for all inventions by others than to Siemens based on a dynamo-electric machine in combination, and is too widely removed from the law and the decisions of the courts to warrant discussion. The next four reasons have been dealt with under the second assignment of error, and require no further elucidation. The last reason is founded on a mistake of fact, for the record shows that Field's application for patent antedates that of Siemens by more than two months.

The foregoing are all the points raised by the appeal, but in argument, counsel for Siemens has alleged the following as a defect, namely, that Field has not filed the supplemental oath required by Rule of Practice 47. Said rule requires "a supplemental oath to the effect that the subject-matter of the proposed amendment was part of his invention, and was invented before he filed his original application," in cases where the applicant seeks by amendment "to introduce any claim not substantially embraced in the statement of invention or claim originally presented, and therefore not covered by the original oath." In this case the amendment was made at the suggestion of the office under the Rules of Practice then in force. The amendments introduced by Field were thus, in the judgment of the office, substantially embraced within the original statement of invention. Consequently, the case is not one where, under the practice, the supplemental oath is required. (C. D. *in re* Eaton *et al.*, iv., O. G., 525.)

For the foregoing reasons, the decision of the Examiners-in-Chief in awarding priority to Field is affirmed.

R. G. DYRENFORTH,
Acting Commissioner.

MARCH 27, 1885.

SUBTERRANEAN WIRES IN PRACTICE.

APPENDIX TO REPORT OF MASSACHUSETTS RAILROAD COMMISSIONERS (See page 115).

[A.]

Notes on the Subject of Underground and Overground Lines of Telegraph Located on Road and Railway for Commercial Working.

The objections to having a number of independent telegraph lines established on a railroad location are: the amount of space taken up by the wires, the interference with the sight of signals and the liability of broken poles causing accidents to trains.

The proper distance from track at which telegraph poles should be placed for railway working is the line of the right of way. For independent working it is the line of the nearest road.

The limit of the extent to which wires can be laid underground is simply a question of insulation, *i. e.*, an insulation which will not retard working, and at the same time prevent interference. Underground wires should be so insulated that no moisture should penetrate the outside covering: it should be reasonably decay-proof, water-proof and fire-proof; it should not carbonize or corrode the conductors. The insulation should be low but the conductors well separated and kept clear from all

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atmospheric influences as well as from the earth. Underground wires are largely used in other countries. London has nearly a complete system, and in Germany there are 221 cities connected together; 3,400 miles in all of underground, containing 23,000 miles of wire. The cost of the German system was $2,639 per mile of 21 wires, placed in pipe and buried at a depth of four feet. This includes labor, material, etc., all ready for use.

Sectional boxes can be laid for $2,000 per mile, sufficient to accommodate several hundred wires.

Brooks' cable system laid through pipe filled with oil, containing from three to four hundred wires, can be placed at a cost not exceeding $20 per line per mile ready for operation.

The objections to the underground are: the liabilityof causing retardation, causing slow transmission of messages, and the trouble and expense in making repairs.

An eminent English authority on the subject of telegraph lines notes: Where there is a choice between an overground and underground system there should be no hesitancy in selecting the former, for not only is the first cost less, but faults occurring upon them can be more readily traced and rectified; but that where there is a choice of location for an overground independent line of telegraph between a road and railway, they both offer advantages and it is no easy matter to say which is to be preferred.

The first cost of a line located on a road is greater than upon a railway, but yet its subsequent maintenance under certain conditions is less; the supervision of it is more perfect, for the fact that the poles are erected along the side induces better inspection and little imperfections are thus easily detected.

On a railway location walking is difficult and consequently too often neglected, the lineman contenting himself with traveling by train, from which close inspection is next to impossible.

The reparation of faults is as a general rule more speedily carried out upon roads than upon railways. In case of the former, the lineman can start immediately the fault is reported to him: with the latter he has not only too often to wait some time for the starting of a train, but frequently is carried past the fault and has to return to it many miles on foot.

For an underground system carrying wires between cities, *i.e.*, outside of street limits, following a railroad or turnpike, a conduit alone can be laid for $1,580 per mile, capable of holding 50 wires. The wires with good insulation will cost $105 a mile each, if separate; if by cable carrying 10 or 15 wires each, the cost would not exceed $85 per mile for each conductor.

Taking this as a basis, a system with provision for carrying 50 wires, with 15 laid in place, would cost, all complete, $2,855 per mile.

In cities, within street limits, the cost of labor to be added to the above depends on the location with respect to pavement or street, but in any case would not add more than $500 per mile to the above. Cross lines leading to houses are not included.

REPORT FROM MR. HAMILTON

As to Western Union underground wires in New York city (there being practically no other underground system), from general office to Pier 18, two parallel pipes of 2,031.50 feet.

4,063 ft. iron pipe, at 20c. per ft.	$812 60
Coating 130 pipes, 1,251 ft., at 3 cents	37 53
Carting	8 00
Laying (two 1,850 ft. parallel) 3,700 ft. of pipe, two pipes in trench, at 22½c	832 50
Setting and cutting 4 flush boxes (test boxes)	72 00
Laying and furnishing stone for 60 yards Belgian pavement, at $2.25	135 00
Elbows, iron work, etc., at cable house (Pier 18)	50 85
Extra labor, etc., at and around Pier 18	60 50
Cable house at Pier 18, N. R., invoice by G. M. P	160 25
	$2,169 23
Two cables of 2,130 ft. each, or 4,260 ft. (30 conductor cable)	$3,424 15
Labor of drawing in	40 91
	$5,634 29

In the latter part of 1876 or early in 1877, two 30 conductor cables (about 2,200 feet each) were laid from the General Office, 195 Broadway, to Pier 18, North River.

Eight or more conductors in one of these cables failed before the end of 1880. These were repaired about October, 1881, by drawing in a new piece in place of the defective portion.

Seventeen conductors in the other cable failed in November, 1880, by breakage of iron conduit under the dock. Overhead wires were substituted until April, 1881, when this cable was replaced by a new one containing 60 conductors.

At the present time three conductors are interrupted, 57 good.

The remaining 30 conductor cable was extended to Pier 16, in February 1882. It was afterwards replaced by another of 60 conductors.

At one time 20 conductors by this route were interrupted by the heat from the Steam Heating Company's pipes, but I am unable now to say whether it was the 30 conductor before its replacement, or the 60 conductor cable.

At the present time 4 conductors are interrupted, 56 good.

A 12 conductor cable, 2,200 feet long, was laid between the office, 195 Broadway, and 14 Broad street, in October, 1876; cable destroyed in October, 1883, by steam pipes.

Has not been replaced.

A 28 conductor cable, 2,050 feet long, was laid May, 1880, between 195 Broadway and 8 Broad street; 11 conductors failed November, 1882. Cause, steam pipes.

Eight conductors working now.

A 30 conductor cable, 500 feet long, was laid between 134 Pearl street and the Cotton Exchange, in May, 1882. At present time two conductors are defective, 28 good.

A 60 conductor cable, 2,778 feet long, was laid between 195 Broadway and 134 Pearl street, in May, 1882. Failed November, 1882. Cause, steam heating. Cable has been abandoned.

A 30 conductor cable, 730 feet long, was laid in Jersey City, December, 1876. Failed October, 1882. Cause, exhaust steam pipe passed underground near cable, melted gutta-percha.

Repaired soon after, and an additional cable put down. All conductors perfect at present time.

A 30 conductor Brooks cable was laid between Newark and Jersey City suburbs in 1880. The wires failed rapidly when put in service. This cable was afterwards repaired, part of the route changed, and considerable new cable added or substituted for defective portions in 1882. It saw scarcely a year's service, however, and none of the conductors are now in use. The experiments with this cable were made at an expense of more than $20,000.

GEO. A. HAMILTON,
Electrician.

MAY 27, 1884.

WHAT EDISON IS DOING.

I found Mr. Edison last week in his laboratory on Avenue B, and asked him what was the newest thought that he had harnessed to matter. "This" he answered, and called my attention to a board hanging by one edge to ropes above our heads, its surface covered with tinfoil. In further explanation he said, "That solves the question of telegraphing to running trains. As soon as that little device is adopted every moving train in the country will become a telegraphic station, and anybody aboard the train may be telegraphed to as easily as if it were standing still. This will not be done by putting up a new set of wires, under the train or at its side, but by using the ordinary telegraph now running by the side of the track. It is a new, and hitherto unknown process of induction, by which I make electricity jump thirty-five feet through the air, carrying the message without spilling it. How's that for lively."

The inventor's face glowed with pleasure at the thought as he went on: "By putting up this tinfoil covered board lengthwise on the top of each car I can catch a message from the wire strung on poles thirty-five feet off, and can fling an answer back to the wire. It requires no change in the wires of any sort. The secret of it is in the machine for transmitting. When I was investigating what I called the 'etheric force' a few years ago I accidentally discovered certain curious properties of static electricity. These I have now applied. The process is very inexpensive, as three men could equip a road 300 miles long for $1,000 in three or four days. It seems certain that its adoption will be general, so that every train will be run from headquarters and every passenger will be accessible to his friends. What do I call it? I haven't named the baby yet." Mr. Edison looked exceedingly well, although he was robed in a gown of bed-ticking reaching from collar to ankles which was not very picturesque.

At the Edison factory in Goerck street a new passenger car of the elevated road is being equipped with the electric motors which are to take the place of the present steam locomotive in the early summer. The car is turned bottom upward, and two dynamos weighing about 1,000 pounds each are adjusted to the under side in proximity to the wheels. One dynamo drives the four forward wheels, and the other the four rear wheels. Every car is to be similarly rigged so as to bear its own motive power. A train of four cars, instead of having one 16 ton locomotive, with two great driving-wheels, will have no locomotive, but every one of the 32 wheels will be a driving-wheel. The 8 dynamos will weigh about half as much as a locomotive, and they will all respond to the touch of one conductor. Mr. Bachelor, in charge of the work, tells me that one car can be run alone in the easy hours, while in the crowded hours ten or a dozen can be run in a train, and that they can reach a speed of 20 miles an hour in the first 300 feet after starting. Mr. Russell Sage, whom I saw yesterday, feels sure that the electric motors will enable the aerial roads to carry one-third to one-half more passengers than they are now doing, and that the trains will be much more safe and manageable.—W. A. CROFFUT, in *New York World.*

THE FAST-SENDING TOURNAMENT.

There were 12 contestants in the test of Morse transmission which took place at the rooms of the United Press, in this city, April 5th. The number of words selected for the competitive trial of skill was 500, composed of 2,368 characters, including punctuation. Both speed and excellence were considered in awarding the prizes. The respective time occupied in transmission was as follows:—J. W. Roloson, Stock Exchange, 10:32; Frank J. Kihm, United Press, 10:38; William Gibson, Stock

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Exchange, 10:57; M. J. Doran, Bennett & Co., 11:26; John G. McCloskey, United Press, 11:44; W. L. Waugh, Stock Exchange, 11:57; Charles H. Davis, United Press, 12:01; William J. Curtis, United Press, 12:27; Walter L. Prentice, United Press, 12:49; R. J. Murphy, Western Union, 12:51; Robert W. Martin, United Press, 12:51; F. G. P. Griffith, United Press, 13:15.

J. W. McLaren, Manager of the Baltimore & Ohio's local office; D. B. Mitchell, chief operator of the Western Union in this city, and Walter P. Phillips, general manager of the United Press Association, acted as judges, and read the matter sent from a local wire in an adjoining room. The first prize was awarded to J. W. Roloson for great speed and remarkable clearness, considering the time made; second prize to William Gibson for unusual speed and pronounced excellence; third prize to Frank J. Kihm for remarkable speed, marred by faults in the formation of characters; fourth prize to William J. Curtis for absolute correctness, speed and beauty of style; fifth prize to F. G. P. Griffith for speed and excellent manipulation with the left hand. The contest was the third ever held in this city, and the time made beat previous records. The first match took place in 1881, when the best time, 11:10, was made by W. L. Waugh, who came out No. 6 in this contest. The second contest came off in August of last year, and the best three men were W. L. Waugh, 11:32; William Gibson second, and Frank J. Kihm third.

TROUBLES OF THE UNITED STATES TELEPHONE MANUFACTURING COMPANY.

The announcement is made that the United States Telephone Manufacturing Co. is in trouble. A judgment for $2,855,21 was obtained by James W. McDonough for money loaned to the company. Execution was issued on the judgment and returned unsatisfied, whereupon sequestration proceedings were instituted, and H. H. Eldred was appointed receiver on April 24th by Chief Justice Daly of the Court of Common Pleas.

This company was organized about five years ago with the design of entering into competition with the American Bell Telephone Co. A large number of patents were secured, some of which were believed to be of great importance, among others those of James W. McDonough, one of the competitors for the honor of having been the original inventor of the speaking telephone ; Geo. W. Coy and Charles E. Buell, who claimed to be the originators of the exchange system, and T. A. Connolly, the inventor of an automatic telephone exchange system. Legal proceedings were commenced against some of the local companies licensed under the Bell patents, alleging infringements of one or more of these patents, which however have never been brought to any conclusion. The expenses of litigations in the courts and of interference proceedings in the Patent Office have probably crippled the United States company, which has been without apparent resources, except the amounts realized from the sale of stock, which since the decision in the Drawbaugh and other cases in favor of the Bell company have probably been very small. The collapse of this company apparently leaves the American Bell company for the present without any antagonist of serious importance in the field.

THE PHELPS INDUCTION TELEGRAPH.

A special and very successful test of Lucius J. Phelps's system of communicating with moving trains was made on March 25th, for the information of members of the New York Electrical Society, who were invited to be present by the company controlling the patent.

On this occasion two sets of apparatus were in circuit on the train, one with an ordinary Morse sounder, the other embracing a receiving telephone, from which the signals could be distinctly read. One of the visiting operators, who had never seen the system in use, sent and received messages while the train was in motion. In order to show the wide margin of inductive influence, a further test was made, while the train was running on a parallel track, 11 feet from the main line, which was equally successful. The result was highly gratifying to all, especially in view of the failure at the previous exhibition on February 13, which is said to have been the only mishap of the kind during three months' trial.

MINIATURE INCANDESCENT LAMPS.

The use of electric incandescent lamps for many scientific and industrial purposes is creating quite an extensive market for lamps of various powers, operated by dynamos, primary and storage batteries. For surgical, dental and microscopical use there appears to be nothing so convenient and effective. Outfits of this character are now to be had thoroughly well made, and reliable in their operation.

Messrs. H. Guimaraes and Co. are devoting their attention to this field, and have perfected a pocket battery which is not only adapted for lighting on a small scale, but convenient for testing, and useful for various purposes.

Messrs. Stout, Meadowcroft and Co., are also engaged in supplying the demand which has arisen for miniature electric lamps, and have already brought out a variety of styles suitable for actual service. All who are interested in this novel branch of electric lighting, will certainly derive pleasure from examining these tiny isolated plants.

ELECTRIC LIGHT AND POWER.

Domestic.

The Electric Locomotive and Railway Supply Co., of New York city, has been incorporated for the purpose of manufacturing electric motors, etc. The incorporators are George W. Titcomb, William Ettinger, J. D. Gillett, Joseph Weis, Francis Weis, Wm. F. Drake, A. A. Drake, Elwood McNab and John Van Wagoner. The capital of the company is $1,000,000.

It is probable that the electric light will cut an important figure in connection with the franchises for lighting streets and dwellings in St. Louis.

The Thomson-Houston Electric Light and Power Co. has been organized at Quincy, Ill.; capital, $100,000; incorporators, William M. Berry, Samuel A. Blasland and Gerald M. Hill.

The Springfield, Ill., city council has passed an ordinance providing that railroad companies shall erect electric lights at all principal streets crossed by said roads. Considerable comment has been caused by this action, as the ordinance was pushed by parties interested in an electric lighting company.

The Jenney Electric Light Co., has been incorporated in Indiana. It is based on the inventions of Charles D. Jenney, heretofore identified with the Fort Wayne Jenney Electric Light Co., with which he has had a contract, made when he was 17 years of age. This agreement was recently rescinded upon his attaining his majority.

Since our last issue the United States Illuminating Co. has installed a plant of 900 Weston incandescent lights in the Washington Building, No. 1 Broadway, and have nearly completed a 150-light plant for the new Mortimer Building, No. 11 Wall street, and another of the same size for the meat house of J. Halstead and Co., on Forsyth street, all in New York city. A 300-light plant is now being fitted up in the building of the Brooklyn *Eagle.*

The Weston incandescent lamp seems to be in special favor for lighting steam vessels. The United States Illuminating Co. are fitting up two new boats just launched by the Grand Street Ferry Co. with 75 lights each.

The new skating rink recently opened at Greenville, N. J., by E. J. Reiss is splendidly illuminated by 12 large Weston incandescent lamps of 125 candle-power; the effect is greatly admired by visitors.

The United States Electric Light Co., have placed a 250-light incandescent plant in the Point Clear Hotel at Mobile, Alabama, and a 100-light plant in Coates and Potts woolen mill at Philadelphia.

We mentioned in a recent issue the fact that the New Montezuma Hotel at Los Vegas, N. M., was being fitted by the United States company with the Weston incandescent lights. Since then the plant has been completed and set in operation. It is worthy of mention that there is not one foot of gas pipe on the premises. This is probably the first hotel in the world lighted throughout every part exclusively by incandescent lamps.

The New York Electrical Society proposes, in place of one of its regular meetings, to spend an evening in visiting and inspecting the various stations of the United States Illuminating Co. in New York. Such an expedition will prove interesting and profitable to the members of the society, as the stations of this company are very complete, and well worthy of a careful inspection by all interested in the industrial application of electricity,

The Holyoke Electric Light and Power Co., of Holyoke, Mass., recently established a 105 arc light plant of the Schuyler system. The city has taken 50 lights for the streets and the remainder are taken by private parties. Both water and steam power for driving the dynamos is furnished by the Holyoke Water Power Co., in whose buildings the dynamos are placed.

In addition to the streets and parks of New York city already lighted by electricity, the United States Illuminating Co. are also to light Catharine street from Catharine square to the East river, Chambers street, from Broadway to the North river; Fulton street, from river to river, and Canal street, from the Bowery to the North river. A petition signed by down-town business men asking that the streets leading to the ferries might be lighted by electricity, cannot be complied with as the available surplus of $12,000 is not sufficient.

Foreign.

At Antwerp, Belgium, a large central station is being fitted up for supplying private houses with electric light. The first in-

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stallation will be for 6,000 incandescent lamps; the dynamos employed in this case will be Gulchers, and the current will be conveyed by means of underground wires. according to Callender's system, placed in cast-iron pipes filled with non-conducting material. This installation, when completed, will be the largest of its kind in Belgium.

It has been decided that in the autumn of the present year several important public buildings of Vienna are to be tentatively lighted by electricity. Between the imperial court and the gas company an agreement has been concluded for the electric lighting of the imperial palace (Hofburg), as well as of two theatres, viz., Hofopern theatre and the new Burg theatre. The central station for the lighting of these buildings is to be established in the Porcellangesse, on the very spot on which, fifty years ago, the first gas works were built. This principal station is to be connected by means of underground wires with several other stations situated in different parts of the Austrian metropolis. There are some Turrettini accumulators, by means of which it will be possible to carry on the lighting of all these buildings without interruption. The Opera theatre will have 4,000 and the new Burg theatre 3,000 lamps; the new section of the imperial palace, and part of the old one, will have 5,000 lamps between them. The installation of the electric light in the Opera theatre and in the emperor's old palace is to be finished in the autumn of the present year; in the new Burg theatre and in the new section of the palace it is to be finished as soon as the buildings themselves are ready for it As regards the introduction of the electric light in the parliament house and the new university, the negotiations are still proceeding. The necessary funds for the above installations have been supplied by the gas company itself.

The Swan patents have become very valuable in Germany in consequence of a decision by the German courts against the two firms, Naglo Brothers and Eisenmann, for infringement of the Swan incandescent lamp patent. The judgment forbids henceforward the manufacture and sale of Swan lamps in the whole German empire in favor of the Edison company. This decision will have a considerable bearing on the development of electric lighting in Germany.

Messrs. Kitson & Co., engineers, Leeds, have had ordered two sets of electric lighting plant to assist in the work of constructing the Suakim line. Each of the two sets of plant will comprise a small locomotive boiler and a Parson's patent high-speed engine, with a six light Anglo-American Brush dynamo-electric machine, with all other accessories. This machinery will be fitted into a four-wheeled specially designed railway wagon, which will be run forward along the lines of the railway as its construction is proceeded with. From the dynamo machine cables will convey the electric current to six Brush lamps, which will be fixed on portable tripods 35 feet high, and placed along the side of the portion of the line under construction at distances of about 100 yards apart.

MANUFACTURING AND TRADE NOTES.

The Western Electric Co. have just completed at their works in Chicago, five miles of underground cable to be used for telephone purposes in Washington, D. C. They are now making additional switch-boards for Liverpool, England, Toronto, Ontario, and Kansas City, Mo., and are making a new one to go to Glasgow, Scotland. Recent orders are for an electric light machine with lamps to go to London, England, and a 40-light electric plant for Morgenthau, Borland and Co.'s store, in Chicago.

The California Wire Works, San Francisco, Cal., is one of the most important industries of the Pacific coast. The wire mills have a capacity of 5,000 tons per annum. The various departments embrace galvanizing and tinning works, machine shop, wire weaving, barbed wire factory, telegraph cables, etc. The works occupy nearly three acres of land.

The trustees of Pope, Cole and Co., of Baltimore, have made a proposition to pay 80 cents on the dollar of the $500,000 unsecured liabilities, of which $100,000 is to be paid in cash, and the remainder on time. The assets are large, and there is a probability a settlement will be made on that basis. Such a result will assure a continuance of the copper works, one of the most important industries of Baltimore.

PERSONAL MENTION.

Col. R. C. Clowry succeeds the late Gen. Anson Stager as president of the Central Union Telephone Co.

THE TELEGRAPH.

The employés of the Bankers and Merchants' Telegraph Co., at Buffalo, N. Y., stopped work on the morning of April 14th in order to enforce a settlement with the company. A compromise was effected next day.

A foreclosure suit for $3,000,000 has been brought against the American Rapid Telegraph Co. by the Boston Safe Deposit and Trust Co., in the United States Court at Hartford, Conn.

The Commercial Telegram Co. commenced an action in the New York Superior Court, on April 16, against the Gold and Stock Telegraph Co., claiming $50,000 damages for an alleged libel contained in a circular issued by the defendants with the object of persuading brokers and others throughout the city not to use the instruments of the Commercial Telegram Co.

THE TELEPHONE.

The committee of three appointed by Speaker Marsh, of the Ohio state legislature, to investigate the telephone companies doing business in Ohio, have prepared a report, in which they say:—"There are about 12,000 complete sets of instruments in use in the state, all owned and controlled by the American Bell Telephone Co., of Boston. These instruments are leased to the local companies at an annual rental of $20 for each set, making the annual tribute paid by these local companies over $200,000. The cost of each set of instruments did not exceed $3.35. On instruments which did not cost the Bell company over $40,000 the company receives over $200,000 annually. The Bell company, before granting a franchise to a local company, exacts from 30 to 35 per cent. of all stock of the local company using its instruments, and from 20 to 25 per cent. of the gross earnings of all toll or extra territorial lines." The committee states that, in its judgment, the Bell company is an imperious and unconscionable monopoly, and should be restricted by legislation, or at least be taxed upon the commercial value of its instruments; also, that the Bell company should be required to pay, in addition to the taxes upon its instruments, a tax upon gross receipts.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions,* 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From March 24, to March 31, 1885 (inclusive).

Alarms and Signals:—*Signaling Apparatus*, F. B. Herzog, 314,292, March 24. *Method of Latent Signal Transmission*, same, 314,293. *Circuit Changer for*, same, 314,294. *Signaling Circuit*, T. D. Lockwood, 314,386. *Indicator*, F. J. Sprague, 314,891, March, 31.

Clocks:—*Secondary Clock*, W. F. Weisgerber, 314,634, March 31.

Conductors, Insulators, Supports and Systems:—*Conduit for Wires*, J. S. Dubois, 314,568, March 31; M. H. Dewey, 314,655; D. Brooks, Jr., 314,-791. *Copper Covered Wire*, J. Spruce, 314,618. *Holder for Lightning Rods*, S. R. Lawshe, 314,385, March 24.

Dynamo Machines and Motors:—*Armature for Dynamo*, C. L. Healey, 314,242, March 24.

Galvanic Batteries:—I. L. Roberts, 314,722, March 31.

Lamps and Appurtenances:—*Arc-Lamp*, C. M. Ball, 314,418, March 24; P. Diehl, 314,567, March 31. *Means for Suspending Lamps*, W. H. O'Beirne, 314,976.

Miscellaneous:—*Means for Generating Steam by Electricity*, W. W. Vaughn and E. D. Eldridge, 314,277, March 24. *Induction Coil*, F. E. Fisher, 314,816, March 31. *Apparatus for Measuring the Flow of Liquids*, W. A. M. Brown and John M. Porter, 314,914.

Protectors:—*Safety Catch*, E. H. Johnson, 314,582, March 31.

Railways and Appliances:—*Car Brake*, H S. Park, 314,709, March 31. *Railway Signal*, W. T. Waters, 314,760, 314,761, 314,762, 314,763.

Storage Batteries:—E. T. Starr, 314,892, March 31.

Telegraph:—*Register*, E. Estienne, 314,525, March 24.

Telephone Systems and Apparatus:—*Telephone*, F. Blake, 314,312, March 24; H. Alabaster, T. E. Gatehouse and H. R. Kempe, 314,304. *Circuit for Telephonic Communication*, H. Alabaster and T. E. Gatehouse, 314,305. *Receiver*, same, 314,306. *Mechanism for Operating Telephone Night Bells*, F. E. Fisher, 314,817, March 31. *Switch*, same, 314,818. *Talking Strap for Switch-boards*, same, 314,819. *Transmitter*, H. Alabaster and T. E. Gatehouse, 314,307, March 24; G. M. Hopkins, 314,841, March 31. *Adjustable Support for Telephone Receivers*, J. M. Fitch, 314,371, March 24. *Mechanical Telephone*, F. C. Ludlow, 314,946, March 31.

Expired Patents:—A list of the more important electrical patents which have expired since March 1, 1885, together with those which will expire during the current month, is subjoined:—A. H. Castle, *Insulator*, 75,365, March 10.—C. F. Varley, *Earth Wires for Telegraph Poles*, 75,492, March 10.—L. B. Firman, *Fire Alarm Signal Box*, 75,743, March 24.—S. S. Laws, *Dial Indicator for Reporting Quotations*, 75,775, March 24.—C. F. Varley, *Insulator*, 75,815, March 24.—J. L. Finn, *Combined Insulator and Lightning Arrester*, 75,889, March 24.—E. A. Calahan, *Dial Indicator for Reporting Quotations*, 76,157, March 23.—C. F. Varley, *Insulator*, 76,358, April 7.—W. I. Reid, *Electro-Magnetic Ship's Log*, 76,521, April 7.—C. G. Page, *Induction Coil Apparatus and Circuit-Breakers*, 76,654, April 14.—E. Gray, *Induction Relay*, 76,748, April 14.—C. F. Varley, *Process of Treating Insulators*, 76,960, April 21.—E. A. Wood, *Electric Steam Engine Governor*, 76,965, April 21.—E. A. Calahan, *Stock Printing Telegraph*, 76,993, April 21.—R. E. House, *Electro-Phonetic Telegraph*, 77,872, May 12.—C. Duraut, *Self-Adjusting Relay*, 78,076, May 19.—W. Perkins and G. G. Tandy, *Insulating Material for Electric Conductors*, 78,125, May 19.

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NEW YORK, JUNE, 1885.

INCANDESCENT LITIGATION.

ON Friday, October 4th, 1878, the electric light was discovered by Thomas A. Edison, of Menlo Park, New Jersey. There can be no doubt about the exact date, for the announcement was made to a reporter on the following day, and formed the particular sensation of the next issue of a prominent metropolitan journal. On Monday the news was telegraphed and published in London, where it at once precipitated a panic in gas securities, in which their total value fell off some millions of dollars. As to the personal identity of the discoverer, we find it certified to in connection with an illustrated article subsequently published in a leading monthly magazine, in which Mr. Edison, in his characteristic handwriting, over his unmistakable signature, modestly says that this is an authentic account of "*my* invention of *the* electric light."

For several months after the announcement of the discovery which was to revolutionize the illumination of the world, the details were carefully withheld from the public, while a syndicate of promoters and capitalists was being formed to exploit the invention. The plan of campaign determined upon was ingenious and unquestionably effective. There are certain metropolitan journals which, as the initiated well understand, may be persuaded, by appropriate arguments, to lend the use of their columns to those who know how to make good use of them. The statements, speculations and prophecies of the gifted inventor are served up to the public in the most appetizing form. They profess to have been derived from him during an "interview" with the reporter; this gives them a flavor of high authenticity, while, on the other hand, in case it becomes necessary to disavow any of the published statements, it is easily done on the ground that the inspired person must not be held responsible for the inaccurate or absurd statements put into his mouth by newspaper men. In this manner the country was flooded with the most extravagant assertions in relation to the alleged capabilities of the new electrical discoveries, all purporting to come directly from Mr. Edison. Thus, he is quoted as saying, on October 5th, 1878, that he had computed the relative cost of light, power and heat generated by his electrical system to be forty-six times (mark the accuracy) cheaper than that obtained in the ordinary way. The statement was made at the same time that the amount of light given by 1,000 cubic feet of gas could be obtained by the Edison system for 12 to 15 cents. On the strength of the continual reiteration of these and other equally preposterous statements, the shares in the Edison company quickly rose to an enormous premium. In February, 1879, the details of the great invention, having been duly patented in foreign countries, were published for the first time. The scientists of the world eagerly scanned the specifications, and then tried their best to look in each other's faces without laughing. The wonderful discovery consisted of the old, old device of a lamp comprising an incandescent platinum wire, a thermal regulator to keep it from becoming overheated, and what was not so old—an electric generator, formed of a gigantic tuning-fork, waved to-and-fro before the poles of an electro-magnet, whereby, in the words of the inventor, "a powerful electric current may be obtained by the expenditure of a small mechanical force," inasmuch as "it is well known that vibrating bodies, such as a tuning-fork or reed, can be kept in vibration by the exercise of but little power"! As the London *Engineer* remarked, this was "probably the very worst magneto-electric machine ever made." The whole apparatus as set forth in the patents, exhibited, in truth, a childlike ignorance, not merely of the requirements of electric lighting, but even of the most elementary principles of general science.

Nearly a year of time, as well as a vast amount of money, was expended in a fruitless attempt to produce a commercial incandescent lamp from platinum or iridium; but, at the best, the results do not appear to have been equal to those which had been attained by Farmer twenty years before. In the autumn of 1879 experiments were commenced with filaments of carbonized vegetable fibre enclosed in high vacua, which gave more encouraging results, and further progress in this direction led to an ultimate solution of the most difficult portion of the problem. In this new direction, however, the essential point of Edison's labors now proves to have been anticipated by W. E. Sawyer and Albon Man. The applications of the rival inventors were placed in interference in the Patent Office in the early part of 1880, and it is not until within a short time that the prolonged contest which ensued was finally decided by the Commissioner of Patents in favor of Sawyer and Man, awarding to them priority over Edison in the invention of an incandescent conductor of carbonized fibrous material enclosed in a transparent, hermetically sealed chamber, essentially the so-called Edison incandescent lamp of to-day.

In the meantime Hiram S. Maxim had also taken up the subject of incandescent lighting, and had produced, by a new process, a vacuum lamp having a filament of carbonized bristol board. A plant of these lamps was set in op-

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eration in the vaults of the Mercantile Safe Deposit Company, in New York, in 1880, which was among the first, if not the very first, commercial installation of the incandescent system made anywhere. Maxim's patents passed into the possession of the United States Electric Lighting Company, and from that time forward a vigorous commercial competition was carried on between that organization and the Edison company. For some time there seemed to be but little difference in the merits of the two systems, but of late, owing to the important improvements introduced by Edward Weston, the system of the United States company has apparently been rapidly gaining in public favor.

The Edison company has persistently claimed from the first to hold the fundamental and controlling patents for incandescent lighting, but has until lately contented itself with reiterated assertions to this effect, without attempting to enforce its claims. It is difficult to account for the policy which this company has pursued in reference to its patents, except upon the theory that its managers were well aware that their professed claims to the absolute monopoly of the art of incandescent electric lighting were destitute of legal foundation.

We give in another column a summary of the more important claims of the patents upon which suits have at length been brought by the Edison company against various defendants, from which it will be seen that the points claimed relate almost entirely to the construction of the incandescent lamp. Some of Edison's claims are certainly broad enough in terms to "cover the exclusive manufacture, sale and use of any and all practical incandescent lamps"; but whether these claims can be sustained is quite another matter. The fact is, that neither the incandescent light itself, nor the system of regulation and distribution now in use can be summarily monopolized in this manner by Mr. Edison. A great deal of very important work in incandescent lighting had been done long before by Professor Farmer and others, and both Farmer and Weston had been constructing successful dynamo-electric machines for years before Edison turned his attention to the subject. All the patents of Farmer, Weston and Maxim are owned by the United States Electric Lighting Company, which has also brought suits against the Edison companies for infringements of these patents.

An important factor in the situation is the recently issued patent of Sawyer and Man, which apparently covers the Edison lamp as now manufactured, and, in fact, any lamp having a carbonized filament of vegetable fibrous or textile material. This claim, however, clearly does not cover the Weston lamp, in which the filament is made of tamadine, a cellulose material without structure or fibre; nor can it, we think, be held to embrace the Stanley-Thompson lamp of carbonized silk fibre. During the long contest in the Patent Office which preceded the issuance of this patent, the Edison company has had ample warning of the position in which it would be placed in the event of the success of the Sawyer-Man claim. We shall be very much surprised if Edison does not attempt to secure an interest in the patent, at least sufficient to protect himself, if not to enable him to enter with a reasonable prospect of success upon an aggressive campaign against some of his minor competitors who make use of similar materials in their lamps.

Even the Chinese have finally learned that, in modern warfare, victories are not to be won by the beating of gongs; no more can priority of invention be established by bombastic effusions in the daily press.

A BLOW AT THE AMERICAN PATENT SYSTEM.

It has been our inclination to refrain from comment upon the decision recently rendered by the Supreme Court of the United States in what is known as the Electric Railway Signal case, for the reason that the points decided arose upon the construction of the claims of a patent for an invention made many years since by the present conductor of this journal, and hence any opinions which we may feel called upon to express are necessarily open to the suspicion of being, in some measure at least, prompted by personal considerations, although the ownership of the patent has long since passed into other hands. We have however received an unsolicited communication upon the subject from a patent solicitor and electrical expert of the highest standing in a neighboring city, which will be found in another column, wherein the extraordinary and unprecedented character of the findings of the Court are forcibly pointed out. In order to enable our readers to judge for themselves whether the criticisms of our contributor are just or otherwise, we have also printed the full text of the opinion.

The far-reaching importance of the decision lies in the fact that it strikes at the very root, not only of most electrical patents, but of all that extensive and valuable class of patents in every department of industry in which a new and improved result is obtained by a novel combination of elements, each of which elements, separately considered, is old and well-known. A reference to the specification and claims of the patent at issue, which will be found quoted at length in the opinion as reported, shows that it was intrinsically nothing more than one of the simplest and most frequently recurring cases of a combination patent.

The object of the invention was the automatic operation of block-signals upon railways, by means of electro-magnets and circuit-closers actuated by a moving train. Mechanism for displaying and concealing visual signals by electromagnetism was well known, while the closing of an electric circuit by the action of a moving train was equally familiar to all electricians. Great numbers of circuit-closers had been invented, mainly of three classes, viz.: those in which the wheel depresses a pedal or lever and closes a key, those in which the deflection of the rail under the weight of the locomotive performs a like office, and those in which a section of the rail itself is insulated and the electric connection is completed by the metallic contact of the wheel therewith. The automatic block-system *per se*, which has long been public property, consists in placing a series of these signals along the line of the railway, each provided with its individual circuit-closer, battery and connecting wires, so as to be operated in orderly succession as the train progresses. The complainant's patent was for a system of circuits combining these old devices in a new way, and the invention, briefly stated, consisted in carrying two continuous battery wires along the line of the road, so that

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all the signals of the series could be operated from one central battery, instead of a number of detached local batteries, thus greatly increasing the utility and lessening the expense of the system. Obviously it was wholly immaterial what particular construction of circuit-closers or batteries, or signal mechanism, or conductors, or insulators, were used, the organization of circuits being the essence of the invention, and not the devices. The defendants used a different circuit-closer, a different signal mechanism, and in part a different conductor, but they nevertheless substituted a perfectly well-known equivalent for each individual element of the patented combination, whereby they were enabled to accomplish precisely the same result, and to gain precisely the same advantages.

The decision of the Supreme Court, therefore, states the law to be, that any patent for a new combination of old elements, by which a new result is produced, may be infringed with impunity by substituting for any one of these elements another equally well-known one capable of performing the same function, provided it is not identical in its construction. It is within bounds to say that fully 95 per cent. of the commercially valuable electrical patents now in force in the United States are of precisely this character, while the proportion in other branches of industry is probably but little less. It is the importance of these facts and the character of the results which must flow from this precedent which must serve as our apology for directing special attention to a matter, which, under other circumstances, would have concerned the parties interested alone, and have been without significance or importance to the general public.

There has, for some years past, been a feeling among inventors and patent owners that the Supreme Court, as at present constituted, is developing a growing hostility towards the entire patent system of the United States, as it has heretofore existed since its reorganization in 1836.

This policy was manifested in the first instance in the remorseless and wholesale slaughter of all reissued patents which have of late years come before the Court for adjudication, commencing with the case of *Miller* vs. *Bridgeport Brass Co.*, in 1882, although it is not too much to say that the majority of these have perhaps deserved no better fate. The present decision affords a strong indication that a similar policy is hereafter to be pursued towards original patents. There can be no doubt that the precedents now laid down are sufficient to ensure the defeat of any patent which may hereafter come before the Supreme Court, in which the invention of the patentee resides wholly in the novelty of a particular combination. This, as we have said, is the case with the majority of the patents now in force.

ON THE USE OF WINDMILLS IN ELECTRIC LIGHTING.

The newspapers of a neighboring city have recently been filled with column upon column of what is by a polite fiction termed "matter," relative to what is going to be done by a certain combination which has recently been formed in the electric lighting business. We venture to suggest that this organized system of newspaper electric-light puffery, whether gratuitous or paid for, is getting to be decidedly overdone. It has reached a point where it has become nauseating. The new "combination," so far as appears, amounts to nothing more than an agreement between two existing companies, one of which sells arc and the other incandescent lights, wherein it is provided that each party, in cases where it cannot sell its own system, will endeavor to introduce the system of the other party; an ingenious practical application of the principle of the donkey race, in which each competitor rides somebody's else donkey, and the one who comes in last wins the purse. This is all well enough, but why make such a to-do over it? Why should an electric lighting company owning a good system, capable of holding its own ground on its intrinsic merits, which is the case with each of the concerns we refer to, descend to such clap-trap advertising, shallow puffery, and general "striving after wind?" In view of the experience of the past few years, what prudent investor can be expected to risk his money in an enterprise carried on by such methods, and by the class of promoters who do their business in that way? The past record of some of the persons most prominently concerned in the speculative electric light enterprises of to-day, is by no means of a character to render precaution superfluous. Under the specious plea of "enlisting the support of local capitalists," it is to be feared that many persons will be induced to invest their little savings in electric lighting enterprises, which are springing up like mushrooms in many places where there is no possibility of a remunerative business, from whence they will eventually find their way into the pockets of these thrifty financiers.

If there are people who feel that they *must* invest their money, there is the Bartholdi Pedestal and Children's Fresh Air Fund, both worthy objects, neither of which will return any dividends, nor can the shares be transferred to other victims, but in the one case at least there will be something to show for the money That is more than can be said for a large proportion of these "local" electric lighting schemes.

THE LEWIS SELF-BINDING INSULATOR.

In his article on the construction of lines for electric circuits, Mr. Thomas D. Lockwood, on page 89 of the March number of this journal, referring to the Lewis self-binding insulator, states that the conception of forming the outside screw in a direction opposite to the internal screw, in order to provide for the simultaneous attachment of the insulator to the line wire and the pin, is due to Frank L. Pope. This statement although technically correct, inasmuch as the device was patented to Mr. Pope on December 25th 1883, in justice to Mr. Lewis, requires an explanation. The invention was original with Mr. Pope, but after the issue of his patent, he for the first time learned that Mr. Lewis had at an earlier date conceived the same invention, and had embodied it in insulators manufactured under his supervision in England. While this circumstance does not of course impair the validity of Mr. Pope's patent, yet there can be no question that Mr. Lewis was a prior and independent inventor of the same device, and it is a matter of simple justice that he should have due credit therefor. In preparing his article, Mr. Lockwood of course had no access to other sources of information than those afforded by the records of the United States Patent Office.

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ARTICLES.

A FOREGONE CONCLUSION.

BY WALTER P. PHILLIPS.

It will always remain, I suppose, an open question whether Mr. Vanderbilt said it or not. However, if he did say it, he said a very sensible thing. What does the public know or care about what is being done for its benefit? My experience has been that the public wants not only this terrestial ball, but, if left to itself, it is disposed to be captious about the color of the ribbon with which the earth shall be tied up when it is presented, and, on the whole, the "dear people" are quite as well off when their thinking, on intricate subjects with which they are unfamiliar, is done by experts.

Can there be but one opinion about the condition of the telegraph business as we find it to-day? Does any one, who knows anything about it, dare deny that telegraph property is losing its value; that the men and women who follow the business for a livelihood are discouraged by the outlook, and that the service is degenerating? And if I ask who has been benefited by the "rate war," which has led to the deplorable condition of things as they exist, I shall be told that the public has had the benefit of the competition. I hope the public appreciates this advantage; but when we come to analyze the matter it will, no doubt, be found that while a good deal of damage has been done, the benefits derived are not of corresponding consequence. Indeed, I shall venture the declaration that no work which is done at less than cost is performed as satisfactorily to the payer as when it is done at a profit. Men and corporations find it cheaper, in the end, to pay large fees to good lawyers than small fees to bad ones. The man whose wife or child hovers on the brink of the grave employs the highest-priced physician he can find; and so this idea of paying handsomely, as a matter of absolute economy and safety, pervades our whole system of commercial and social life, as applied to all matters of importance.

Assuming that I am right in the foregoing conclusion, the question narrows down to whether or not the convenience of instantly exchanging communications between distant points is an important or an unimportant matter. As a large employer of the telegraph, I have no hesitation in saying that it is one of the most important matters imaginable, and I shall argue the case from that point of view. A reduction of rates has invariably resulted in a deterioration of service. When the rates were at a fair and equitable figure the salaries of employés were kept at a point sufficiently high to retain the cream of the profession in the business. With the reduction of rates—a scourge upon the companies and their employés—all the operators who could get away from the general telegraph offices lost no time in going. As is usual, the best men were the ones who departed first, and probably a larger number of them have found comfortable places of refuge during the past year than during any three years preceding. With their earnings reduced below a paying point, through competition, the companies had no course open to them but to curtail expenses, and this has been done by gradually filling the places of first-class operators, as vacancies occurred, with men, women and children of second, third and fourth-class ability. The public gets the benefit of having its business handled by these youthful apprentices, and the yahoos from the highways and byways who have been brought in simply because they can be hired cheaply. In many cases offices have been turned over, even in cities of some size, to a mob of illiterate and irresponsible boys. The public, which once had its business transacted at living rates, by men of intelligence, education, zeal and care, now has it slaughtered, in many cases, by persons unfitted for telegraphic work. But the public gets its work done cheaply, you say. If paying 10 cents for sending a telegram from New York to Boston, and having to hire an interpreter to decipher it; or if getting the benefit of a 15-cent rate to Chicago, and having to spend half a day getting messages repeated, constitutes a net saving, then I am not a good mathematician. It all reminds me of the simple fellow who fancied he was being helped, on his way from Buffalo to Albany, by a canal-boat, because he was permitted to drive the horse and trudge along the towpath on foot.

I do not mean to say that there are not thousands of superb operators in the employ of the numerous companies, or that much of the telegraphing is not better done to-day than it has ever been done before in the history of the business. But I do insist that the average work is far inferior to what it was 10 years ago, and that the tendency of the business is downward. I maintain that the effect of low rates, with their inevitable accompaniment of reduced salaries, has been to drive the best men into other pursuits, and to let in the men whom nature intended for hewers of wood and drawers of water. I believe that this is all wrong, and that all telegraph men, all business men, and all sensible folks everywhere, should welcome any change in the situation that is calculated to relegate these apprentices to their primeval obscurity, and tempt back into the business the bright, zealous and conscientious experts who are being crowded out of it. Higher rates, better salaries and fair profits are the only agencies that will work this change. The telegraph business, as it is running now, is making alarming progress toward the bottom of the hill; and, in my judgment, it is altogether too valuable an adjunct of civilization to be allowed to go to utter ruin without a protest from all sides.

The rate cutting began in earnest with the advent of the American Rapid Telegraph Co., an organization which operated a so-called "fast" system. This company entered the field with the avowed purpose, as announced in its pamphlet, of "moving the United States mails." In the zenith of its career, when its automatic system was in full feather, and after it had sunk for its promoters several millions of dollars, the "Rapid" was equal to the emergency of getting a telegram from Boston to New York in three or four hours. Its rates were low; it was as disregardful of the text as a dissenting preacher, and it employed a collection of human curiosities, the like of which the world had never seen before, and which I hope a kind fate may save us from ever seeing again. I remember that an agent of mine, who had gone over to New York, employed the "Rapid" line in informing me, at Washington, what he had accomplished. His telegram arrived about noon, and read: "The whole matter has been refused to George D. Forrest for the invitation of reporters. Shall be home in the morning." I did not know Mr. Forrest, but I naturally regretted that anything had been refused to him. However, I was glad, in a fraternal sort of way, that the reporters had been invited, and, taking it all around, everything seemed to be shaping itself admirably. But I didn't know what it all meant, and, up to 10 o'clock that night, the Washington manager hadn't been able to clear up the mystery. However, my agent was coming home in the morning, and that was comforting, for on his arrival I should be let into the secret at which he so darkly hinted. I went home wondering how much economy there was in sending for 15 cents 20 words that people couldn't understand, when for 30 or 40 cents my telegram might have been sent by the Morse lines and delivered to me so as to be intelligible. That and dozens of similar experiences have convinced me that the best telegraphing is the cheapest, and my view tallies very closely with that of hundreds with whom I have compared notes at different times, and some of whose experiences were funnier than mine. The enigmatical telegram, as filed in New York, read: "The whole matter has been referred to General Eckert for investigation and report. I shall be home in the morning." The agreeable and courteous general probably does not know that he once figured as "George D. Forrest;" but

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great and small suffered alike when the perforator, the person who turned the crank, and the typewriting young woman of the old "Rapid" days had manipulated a name; and General Eckert was not more badly treated on this occasion than Mr. I. A. Sherman, the general superintendent was, every day or two, when he was transfigured and made to appear as "Jasherman." It has often been asked how the Rapid company managed to keep the field. The secret of its continued existence, hampered as it was by a system that was certainly unique, rested in the fact that setting out with men like Gerritt Smith, H. J. Pettingill and George Hinman, it always had in its employ a sprinkling of excellent Morse operators, and those men leavened the whole loaf. These Morse men finally saved the credit of the company by gradually introducing Morse; and while it was out of the question to make the concern pay, on the basis of 15 cents for 20 words, the "Rapid," from doing the worst telegraphic work, came to do as good Morse work as was ever done by any company. Finally, it was overborne by the telegraphers' "strike," and when it recovered from that and adopted the Western Union rates, it went on with a moderate degree of prosperity, until its officers listened to the song of the siren and surrendered their property into strange hands.

Mr. A. W. Dimock shot across the telegraphic horizon like a meteor. In an incredibly short space of time he had merged the Bankers and Merchants', the Rapid, the Southern, the Board of Trade, the Pacific Mutual, the Michigan Postal, and I don't know how many other companies under one management. He brought about him capable telegraph men, and the word went forth that the greatest opposition system that had ever been projected was about to be established. It certainly looked so at one time; but one sad day, about a year ago, when there was a flurry in Wall street, bright little Mr. Dimock turned up very badly bent, not to say absolutely broken, and the name of the Bankers and Merchants' has been a synonym for pecuniary distress from that day to this. Its financial embarrassments and the competition, at low rates, by the Postal Telegraph and Cable Co. have made bad matters worse. The former company has been forced to reduce prices or close its doors. Simultaneously it has been the sport of receivers and the prey of lawyers, and in the short time the court has had it in charge it has run behind nearly $200,000, while its floating debt is a thing of infinite variety. Meantime it is currently reported, and is probably true, that the Postal Telegraph and Cable Co. will soon go into the hands of a receiver or be "re-organized." So we have thus far the Rapid, the Bankers and Merchants' and the Postal companies, whose attempts to do telegraphing for practically nothing have ended in complete and overwhelming disaster.

The rate cutting inaugurated by the Rapid, drifted into by the Bankers and Merchants', and taken a hand in by the Postal, has also been carried on with vigor by the Baltimore and Ohio and the Western Union, the latter making its fight through branch offices, where the banner of the absorbed and virtually defunct Mutual Union is thrown to the breeze. These companies are both rich and can stand going to war if they like it better than peace. All the same, much business is no doubt drawn from the Western Union, and done at a loss by the arrangement that company has for using Mutual Union stationery and accepting Mutual Union rates. As for the Baltimore and Ohio, its best friends are not certain it is paying expenses, while it goes without saying that if the Western Union were doing a business which investors and speculators believed would enable it to continue the regular payment of dividends, its stock would not be selling at 59¾—the market price as I write.

Having glanced cursorily at the most prominent features of the case, I reach the conclusion that the Bankers and Merchants' and the Postal must go to the wall; that the curtain must be dropped on the Mutual Union divertisement, and that the Baltimore and Ohio and Western Union, succeeding to the entire telegraphic business of the country, must arrange between themselves to charge higher rates. The employment of a better grade of operators would naturally follow, and the public, instead of having cheap work at ruinous rates, would have good work at fair rates. Whether the bankrupt companies shall turn their property over to the Baltimore and Ohio or the Western Union, or whether it shall be sold at forced sale to whomsoever will bid for it, is a question. But that the lines, outside of the Baltimore and Ohio and the Western Union, cannot be operated, except at a loss, is so palpable a fact that no one is likely to dispute it. A country as large as this, is surely entitled to two telegraph systems, and both should be first-class. A combination of all telegraphic interests would precipitate the government telegraph at the next session of Congress, and it is safe to assume, I think, that neither Mr. Gould nor Mr. Garrett would relish having the government as a competitor. As between a telegraph monopoly, in private hands, and the governmental control, I should favor the latter. But if two comprehensive and efficient systems of telegraphs can be kept in the field, it will be better for the public and for employés than one system conducted by the post-office department. The existing situation presents a problem that will, perhaps, solve itself in the near future; but so far as I can see, it is susceptible of but one solution—the one I have outlined herewith.

THE EDISON CLAIMS SUMMARIZED.

The Edison Electric Light Co., having at length completed their preparations, commenced on May 2, 1885, a number of suits in the United States Circuit Court for the Southern District of New York, against the United States Electric Lighting Co., the United States Illuminating Co., the Consolidated Electric Light Co., and the Swan Incandescent Electric Light Co., for alleged infringements upon the patents of the Edison company relating to incandescent lighting. Additional suits have been instituted against a number of representative users, among others the National Park Bank, and the Mortimer estate using the Weston system, and the First National Bank, the Bank of the Republic and W. H. Jackson & Co. using the Consolidated or Sawyer-Man system. Thirty-four different suits are brought against the United States Electric Lighting Co., its licensees, and customers, alone.

The Edison company claims that its patents cover the exclusive right to manufacture, sell and use, all practical incandescent electric lights. Edison himself asserts that "subdivision" and "high resistance" are his discoveries, and the great principles upon which his patents are based. The claims of the patents themselves, serve very well to show the position of the *prima facie* case of the Edison company, and we accordingly subjoin all those which appear to be of importance, in the several patents upon which suits have been brought.

The first group of patents relates to the construction and manufacture of incandescent lamps, and the essential claims are as follows:—

Edison's patent No. 227,229, filed April 21, 1879, issued May 4, 1880.

> In an electric lamp, the combination, with a hermetically sealed vacuum-chamber made entirely of glass, of metallic conductors passing through the glass and around which the glass is melted, and an incandescent conductor placed in the electric circuit.
>
> The method herein specified of treating metallic conductors for electric lamps, consisting in inclosing the conductor in a glass case, exhausting the atmosphere from such case, heating the conductor by an electric current, and then hermetically sealing such glass case.

Edison's patent No. 223,898, filed Nov. 4, 1879, issued Jan. 27, 1880.

> An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires.

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The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted.

Edison's patent No. 230,255, filed Feb. 5, 1880, issued July 20, 1880.

The method of forming electric lamps, consisting in separately forming the inclosing globe and the supporting bulb for the incandescent conductor, attaching the wires and incandescent conductor thereto, and then hermetically uniting the parts prior to the formation of the vacuum.

The method of hermetically sealing a vacuum-chamber, which consists in first sealing *in vacuo* and then sealing in air.

Edison's patent No. 239,153, filed Aug. 27, 1880, issued March 22, 1881.

The combination with the glass inclosing globe and incandescing conductor of a support hermetically sealed to the globe and supporting the carbons at a distance above the point of sealing.

Edison's patent No. 239,149, filed Dec. 15, 1880, issued March 22, 1881.

An incandescing electric lamp, the supporting neck formed with a concavity at the point where the leading wires pass through and are sealed therein.

The supporting neck formed with a solid glass projection, to and upon which the inclosing globe is supported and sealed.

Edison's patent No. 248,419, filed April 15, 1881, issued Oct. 18, 1881.

In an electric lamp, the combination of a piece of platinum sealed into the glass, and terminals of other metals affixed thereto, one extending into the lamp for union with the incandescing conductor, and the other protruding therefrom for connection to the ordinary conductor.

Edison's patent No. 266,447, filed April 26, 1881, issued Oct. 24, 1881.

The method of manufacturing incandescent electric lamps, consisting in forming the inclosing bulb or globe directly from molten or pot glass, forming separately the supporting tube or neck for the incandescent conductor, sealing therein the leading-in wires, attaching the carbon thereto, and then hermetically uniting the parts by a welding together prior to the exhaustion of the lamp.

A leading-in wire composed of a central platinum section for sealing into the glass an outer section and an inner section, having a clamping device formed integral therewith.

Holzer's patent No. 264,698, filed Nov. 28, 1881, issued Sept. 19, 1882.

The method of sealing the leading-in conductors into the central tubular carbon support of an incandescing electric lamp, consisting in squeezing the open upper end of the tube upon such conductors and at the same time closing air-tight such end of the tube.

The second group of patents relates to the material and mode of treatment of the carbon filament as follows :—

Edison's patent No. 251,540, filed Aug. 6, 1880, issued Dec. 27, 1881.

An incandescing carbon conductor for electric lights, made from cane, bamboo or similar fibre.

Edison's patent No. 265,777, filed Dec. 15, 1880, issued Oct. 20, 1882.

The method of treating the carbon filament of an incandescing electric lamp, consisting in raising such carbon filament to a higher incandescence than that at which it is designed to be used, during the latter part of the process of exhausting the lamp-globe, whereby the air and gas are driven from the carbon filament and from its enlarged ends and clamps, and the flexibility of such filament is increased and its shape fixed.

Edison's patent No. 307,029, filed Oct. 12, 1882, issued Oct. 21, 1884.

The process of forming the flexible incandescing filaments of electric lamps, consisting in first forming a straight filament of carbonizable substance, then carbonizing the same, and finally bending the flexible filament thus formed into the desired shape.

The third group of patents relates to the mounting of the incandescent lamp upon its supporting fixtures as follows:—

Edison's patent No. 265,311, filed Feb. 5, 1880, issued Oct. 3, 1882.

A separate electric lamp, consisting essentially of an inclosing globe entirely of glass, an incandescing material secured therein, conductors leading thereto and sealed in the glass where they pass there-through, and a base of insulating material in which the neck of the globe is secured, said base being provided with metallic contact-plates to which the conductors leading into the globe are secured at their outer ends.

A socket for an electric lamp, adapted to be placed upon a gas-pipe or other suitable support, and provided with contact-plates forming the terminals of an electric circuit.

The combination of a separate electric lamp made and provided with a base as described, and a socket adapted to be secured upon a gas-pipe or other suitable support and provided with contact-plates so that the two may be readily attached and detached.

Edison's patent No. 248,424, filed Mar. 26, 1881, issued Oct. 18, 1881.

The combination of a base-piece such as described, a lamp or chandelier standard, a safety-catch and a cap covering the base-piece.

The combination of a pendent incandescing electric lamp and a socket to which said lamp is removably attached, with an open-flaring reflector supported by means attached to or above said socket, whereby the downward reflection of the light is uninterrupted and the lamp can be removed from and placed in said socket without disturbing the position of said shade or reflector.

Edison's patent No. 251,554, filed Mar. 26, 1881, issued Dec. 27, 1881.

The combination, with an incandescent electric lamp and its socket, detachable from each other and adapted to be used in a complete or round wire circuit, of controllable means for positively holding them in position together, and means for automatically completing the circuit connections between them through both limbs or members of the circuit upon placing them together in position.

The combination, with a separately removable incandescent lamp and its socket, of means for holding them positively in position relatively to each other.

THE UNITED STATES COMPANY'S CLAIMS SUMMARIZED.

The United States Electric Lighting Co. have brought suits against the Edison companies, in the United States Circuit Court of the Southern District of New York, alleging infringements upon a number of patents of which it is the assignee and owner. Two of these patents relate to incandescent lamps, and contain among others, the following claims :—

Maxim's patent No. 244,277, filed Dec. 8, 1880, issued July 12, 1881.

In an electric lamp, a continuous incandescent conductor inclosed in a transparent vacuum-globe, in combination with conducting-wires leading to said conductor, each of which is divided where it passes into the globe into two or more branches, to which the material of the globe is directly sealed by fusion.

Maxim's patent, No. 254,032, filed March 31 1881, issued Feb. 21, 1882.

In an incandescent electric lamp, the combination, with the conductors sealed therein, of a continuous conductor of carbon gradually enlarged at or near its ends.

Two other patents relate to the winding of the armature of the dynamo machine.

Weston's patent, No. 259,618, filed Dec. 31, 1881, issued June 13, 1882.

An armature wound with two systems of coils in diametrically separate divisions, the divisions of one system being alternately under and over those of the other, and the said divisions being looped together and connected to the commutator.

Weston's patent, No. 277,644, filed Jan. 9, 1883, issued May 15, 1883.

The combination, with an armature-core, of a system of conductors composed of massed strands or strips of conducting material.

The combination, with a cylindrical armature-core, of a system of conductors wound thereon, and composed of groups or bundles of fine wire, each group being spread out at the ends of the core.

The next two patents relate to the system of distribution and regulation employed.

Farmer's patent, No. 252,836, filed June 7, 1881, issued Jan. 24, 1882.

In an incandescent electric lighting system, the method of uninterruptedly controlling the strength of current of a main line of continuous conductors by and correlatively with incidental variations of strength in the same current traversing a continuous branch circuit.

In an incandescent electric lighting system, the method of varying the strength of current of a main line of continuous con-

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ductors by dynamic effects produced by variations of strength in the same current traversing a continuous branch circuit.

The combination of a generator of electricity, two or more separate branches or derived circuits connecting the poles or main conductors of said generator, one or more electric lamps included in each of said branches, an adjustable rheostat included in that portion of the circuit of the generator common to all the lamps and mechanism, whereby the resistance of said rheostat is diminished as the joint resistance of the whole number of lamps is increased, and the reverse.

Farmer's patent, No. 253,817, filed March 7, 1881, issued Feb. 14, 1882.

The combination of a rheostat, mechanism for increasing or decreasing the resistance of said rheostat, an electro-magnet included in the same electric circuit with the rheostat, or in a branch thereof, and a lever for controlling the action of said mechanism, which is normally balanced between the attractive force of said electro-magnet and a constant antagonistic force, and contact-stops for limiting the motion of and determining the action of said lever.

Another patent is for the fusible "safety-catch."

Weston's patent, No. 259,614, filed Jan. 5, 1882, issued June 13, 1882.

The combination, with a circuit or branch thereof, of a safety device which fuses at a temperature below the ignition-point of wood, paper, fabrics, or other like combustibles.

The combination, with an electrical conductor, of a strip or wire of higher resistance than the said conductor, and which fuses at a temperature lower than the ignition-point of wood, paper, fabrics, or other like combustibles.

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 173.)

There are one or two other points on the attachment of insulators which it may be well to refer to.

If it is found that any insulator, when attached to a bracket, touches with its edge the shoulder of the bracket, that bracket should at once be discarded, as all the conditions of a bad escape are thus prepared. Before such a bracket is used it should be shaved off so that there is no contact except on the attaching screw; moreover, neither glass insulators, brackets nor rubber hooks should be attached horizontally, as such a method of attachment is simply preparing an easy way for a driving rain to enter the insulator—possibly to leave water standing in the hollows thereof.

STRINGING WIRE ON POLE-LINES.

The size of wire being decided upon, the coils are mounted horizontally on suitable reels, which may be placed in a wagon, and drawn by a horse from pole to pole, or which, in the case of more modest constructors, may be carried on a hand-barrow, or even carried on a short pole. The last named expedient seems, however, to be more crude than is necessary, as almost any amateur constructor can make a suitable reel, and mount it on a wheel or hand-barrow.

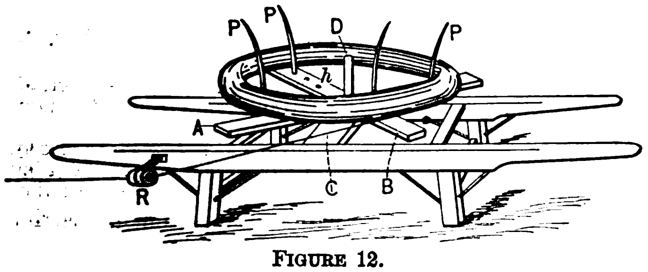

FIGURE 12.

The reel shown in the figure is a very handy one, and can easily be managed by one man.

The two cross-pieces, A and B, should each be about three feet long, two inches thick and three wide, and they rest on the stationary cross-bar, C, by means of the iron centre-pin, D, which may be about six inches high, and an inch and a half thick. The centre hole should be fitted with a bushing of iron; if the hole through the wood is made larger than the pin, a couple of iron plates may be made to serve instead of the bushing; they must be bored at the centre to fit the pin, and then fastened to the upper and lower surfaces of the cross-pieces, so that they will revolve easily on the pin.

A number of holes, *h*, may be bored in the cross-pieces, so that the pins, *p*, may be changed to fit reels of various sizes. A metal or glass ring, R, may be attached to an iron clamp, and fastened to the side of the barrow for the wire to pass through. Lieut. Swift, in his recent work, "The Practical Telegrapher," suggests for this purpose an ordinary glass insulator, with the top punched out. The number of men required to string wire varies almost as much as any other feature of the business. I have strung wire with but two men—one to climb, and one to watch the reel and pull up; but I have also worked a force with as many as six climbers, and it is needless to say that in the last case the work was done much quicker, and in some degree better, as many times circumstances occur in which a number of hands can be economically employed. Each climber requires a pair of good pliers, a pair of climbing spurs, and a supply of tie wires.

The reel is advanced along the line for some distance ahead, and before any wire is attached the person in charge should have the wire laid at the foot of the poles, and examined for faults and unsoldered joints, as no such defect ought to pass unremedied. When the end of the coil is reached, the beginning of the next should be jointed to it while a considerable length of the former is still on the ground.

The wire thus examined may be now picked up by the polemen, who, many or few, should all climb at once, the wire being thrown over their arms.

The tie-wire is made to embrace the insulator in the wire groove, and the line-wire is then placed in the opposite side of the groove over the ends of the tie-wire, which are then turned upward. Before completing the attachment the line-wire must be tightened up by the man or men in charge below.

This is best done with a block and tackle, but quite frequently has to be done by hand. When it is pulled sufficiently taut, the climber gives each end of the tie-wire a turn and a half around the line-wire, and then cuts off the ends, thus completing the attachment.

TIE-WIRES.

Tie-wires may be cut from the wire to be strung, and need not, as a rule, be more than 12 or 14 inches long. If the line conductor is a copper wire, the tie-wire must also be of copper; this is a most important point, and to use iron tie-wires for copper lines is simply to prepare future trouble, as galvanic action may be expected from such a combination. When a copper line is being attached, great care must also be taken not to twist the tie-wires too tightly, as the copper wire is liable to be cut into or otherwise damaged. A number of methods have recently been adopted to some extent with copper wire, in which the tie-wire is made to support the line-wire altogether, and is bound round it, as well as round the insulator; but, if well done, I regard the old-fashioned method as being equally serviceable.

STRAIN.

Very rarely in the United States is sufficient attention paid to the matter of strain, and yet it is one of the most important in line construction. The degree of tautness with which a line-wire is originally stretched frequently determines its durability. If a wire is pulled up too tight, it will sooner or later break; if left too slack, it will cross with others. How is the proper mean to be arrived at? This subject has been brought to an exact science in England, and we shall do well to profit by the practice which obtains there.

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The maximum tension of any span should be one-third of the breaking strain. No. 8 iron wire, for example, has a breaking strain of 1,200 pounds, and the tension with which it is drawn up should therefore not exceed 400 pounds. No. 12 iron wire has a breaking strain of about 510 pounds, and should not be pulled up with a greater tension than 170 pounds.

But it will be objected, How is it possible to know what tension is given to a span without wasting valuable time, and putting more work into it than it is worth? This is where the results of experience are utilized.

It has been found that the dip of a wire, by which is meant the difference between the lowest point of the span and the level of the supports, is just about 24 inches in a span of 100 yards, when the tension is one-third of the breaking strain, and knowing this, we can readily apply it to spans of any length. The dip increases, not with the distance between the poles, but as the square of the number of times that the distance is increased. If, for example, in a span of 50 yards we have a dip of one foot, for double that distance, 100 yards, the dip will be 2×2, or four feet; for four times the distance, or 200 yards, the dip would be 4×4, or 16 feet. Therefore, if we wish to know what the dip of any span should be, on the standard of 24 feet to the 100-yard span, we simply multiply the original dip by the square of the length of the proposed span, and divide by the square of the length of the original span. Suppose, for example, that I wish to know the dip for a span of 80 yards, I multiply the standard dip, 24, by the square of 80, and divide by the square of 100, finding as a result the required dip to be approximately 15½ inches.

The mathematical formula is:

$$R^2 : \quad r^2 : : \ D : d \ or \ \frac{D \times r^2}{R^2}$$

R being the length in yards of the original span; *r* the length in yards of the proposed span; *D* the standard dip, and *d*, the proposed dip. From the above considerations *I* have deduced the following table:

Poles to the mile.	Dip of wire at centre of span.
15	34½ inches.
20	19½ "
25	12 "
30	8 "

It must be remembered that these dimensions are the maximum figures, and that they are calculated for a temperature of 60° F. They hold good, however, for all sizes of iron wire alike, and thus only one wire on a line of poles need be closely calculated for; the remaining wires only need to be pulled up parallel with the first. Wires strung in the summer, must be suspended a little slacker than those put up in winter, as iron wire expands about $4\frac{1}{10}$ inches per mile for every ten degrees of rising temperature. There is still another quite important point about strains—this is, that the tension is least at the centre of the curve, and greatest near the poles. In very long spans we may avail ourselves of this fact, to advantage, by introducing a lighter wire into the middle of the span. By so doing the ends will not have so much weight to carry, while the centre will still be strong enough to resist the lessened strain of the lowest point.

An important application of these rules lies in regulating the tension with which the supporting wires of aerial cables are pulled up. In many places I have observed that such suspending wires are pulled up nearly to a level. This however, is a most injudicious practice, as a wire so pulled up is too tight, even if it had no extra weight to carry. A wire so drawn up cannot be expected to stand well, and, moreover, places far too heavy a strain on the poles or supports. Much of the strength of a wire stretched to such a degree, is taken up in holding itself together against the constant tendency which its particles have to pull apart. Furthermore, if a wire is so pulled up in mild weather, it can scarcely be expected to stand in cold weather, when the strain will be enormously increased.

When copper wire is used, a new basis for calculation must be formed, as the standard of a dip of 24 inches in a 100 yards does not hold for any other metal than iron. It is still, however, proper to adhere to the maximum tension of one-third of the breaking strain.

It is clear, then, that we must, to find the maximum strain which should be allowed to copper wire spans, first ascertain the breaking strain or tensile strength of the copper wire, then taking one-third of that, note the dip produced in a 100 yard span (or a shorter span, according to the law of squares, referred to already), under a tension of that amount, which will give a new standard for copper wire.

No. 12 B. W. G. hard copper wire is found, for example, to average a breaking strain of 566 pounds; and, therefore, should be pulled up with a maximum strain of 188 pounds.

Where a wire runs through foliage which cannot be trimmed, short pieces of heavy kerite wire may with profit be inserted in the line circuit.

JOINTS OR SPLICES.

I suppose that defective joints have given rise to more trouble in electric circuits than any other single fault. It is really surprising how much annoyance a single bad joint can produce, and how much resistance it can introduce into an otherwise good line. This is due partly to the great number of splices in a line, partly to the too frequent lack of care with which they are made, and partly to the difficulty with which an imperfect splice is located, and to the impossibility of a close inspection, when the suspected splice is about midway between two poles. It is quite obvious, therefore, that jointing is one of the most important operations which a lineman is called upon to perform, and all linemen should be carefully instructed as to the absolute necessity of nothing less than perfection in such work. Each manufacturer's joint ought to be examined, while the wire is lying at the foot of the poles, immediately before stringing, and any found defective, or even suspected, should be cut out and made over. Although more attention is now justly paid to this branch of construction, than has been the case in the past, it is to be feared that even yet the extreme importance of extra care is underrated by the majority of persons engaged in line construction. Soldering every splice adds almost indefinitely to the working capacity of a line, yet comparatively few constructors regard joint soldering as being as much a part of their work as fastening the wires properly to the insulators. The consequences of neglect are, in fact, much more disastrous and far-reaching. No unsoldered joint should ever be permitted to go into a line. No twist-joint can, if left unsoldered, long stand the oxidizing powers of the elements.

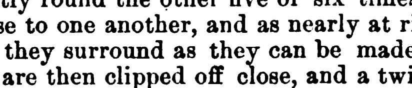

FIGURE 13.

The figure above well represents the characteristic American joint. It is not as neat a joint as some others, but it is easily made, hangs well together, and when thoroughly soldered constitutes a very good splice. In making it, the ends should first be brightened, and then put together and held by a vise, while each end in turn is wound tightly round the other five or six times, the turns passing close to one another, and as nearly at right angles to the wire they surround as they can be made. The extreme ends are then clipped off close, and a twist given to the middle of the joint, to bring the two wires into still more intimate contact, after which the joint is soldered and is then complete.

(*To be continued.*)

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BOLLMANN'S DYNAMO.

BY OTTO GRÜNINGER, C. E.

(From private communications of L. Bollmann, of Vienna.)

ONLY a few weeks ago the first tests were instituted at Vienna with an experimental machine of this type. The results obtained were remarkable. With a total weight of the machine of but 1,540 lbs. (700 kilos), and with 775 revolutions per minute of the shaft, a current of 55 volts potential was generated, which supplied 700 incandescent lamps of 12-candle power each; every part of the machine, armature as well as field magnets, remaining perfectly cool. Varying the numbers of the lamps, a reduction from 700 to 100 caused a variation in the potential of the current of only five volts; between 300 and 100 lamps the variation in potential amounted to three volts, and between 700 and a single lamp the difference in potential was eight volts. Yet there were no special devices of any kind to regulate the current.

The actual capacity or limit of this machine in the generation of currents could not be established. The accomplished results having been beyond expectation, the shaft had been made only 1⅞ inch (48 mm.) in diameter, and it was already taxed beyond its safe torsional strength when supplying the powerful current for 700 lamps. When, therefore, 1,000 lamps were connected, the speed was reduced to avoid breakage of the shaft, so as to correspond to an admissible power. It was then kept constant at 725 revolutions per minute, and the number of volts dropped to 38.

Bollmann's dynamo belongs to that class of machines which contain no iron in the armature, and in which the induction in copper coils or conductors, while passing a magnetic field, takes place directly, and without the intervention of the alternately growing and vanishing magnetism of iron cores. The principal and characteristic feature is to be found in the peculiar construction of the armature disc, which admits of practically utilizing the whole available volume of the disc for conductors, every portion of which is assisting in the generation of useful currents, and which also, at the same time, admits of a most intense magnetic field. One arrangement of the stationary field magnets is another novel and interesting point.

In figures 1 and 2, A A is the bed-plate of the machine, with bearings for the driving-shaft, B; D is the armature disc, which, by means of a double flange, C, is firmly clamped and secured to the shaft. An insulating substance between the flanges and the disc prevents any undue contacts or connections. The two standards, E E, are bolted to the bed-plate, and form the supports for the stationary electro-magnets, G and F. These field-magnets are of small size only, and they are paired around the two standards in such a manner that poles of opposite polarity are always facing each other—with the armature disc between them—while, on the same side of the armature, or on each of the standards, north and south poles follow one another around the circle. The machine, as shown in the drawings, has 16 pairs of such magnets. They are either arranged in the manner described, and as represented by the magnets, G G, in which case the pole-pieces approach the disc, D, as closely as possible without obstructing in the rotation of the latter, and all the poles are active in producing magnetic fields; or Mr. Bollmann connects in a novel manner every second pair of magnets around the disc by a bridge-piece, F, figure 2. In figure 1, the pair of magnets connected in this manner is also designated by the same letters, F F. The bridge-piece neutralizes the free magnetism of the magnets, F F; but as these latter are in metallic connection with the next following pair, G G, through the iron standards, E E, the free magnetism of these magnets, G G, or their magnetic field, is doubled in its intensity. The pole ends of F F and the bridge-piece, not acting themselves directly upon the disc D, are shaped so as to give ample room to the rotating-disc

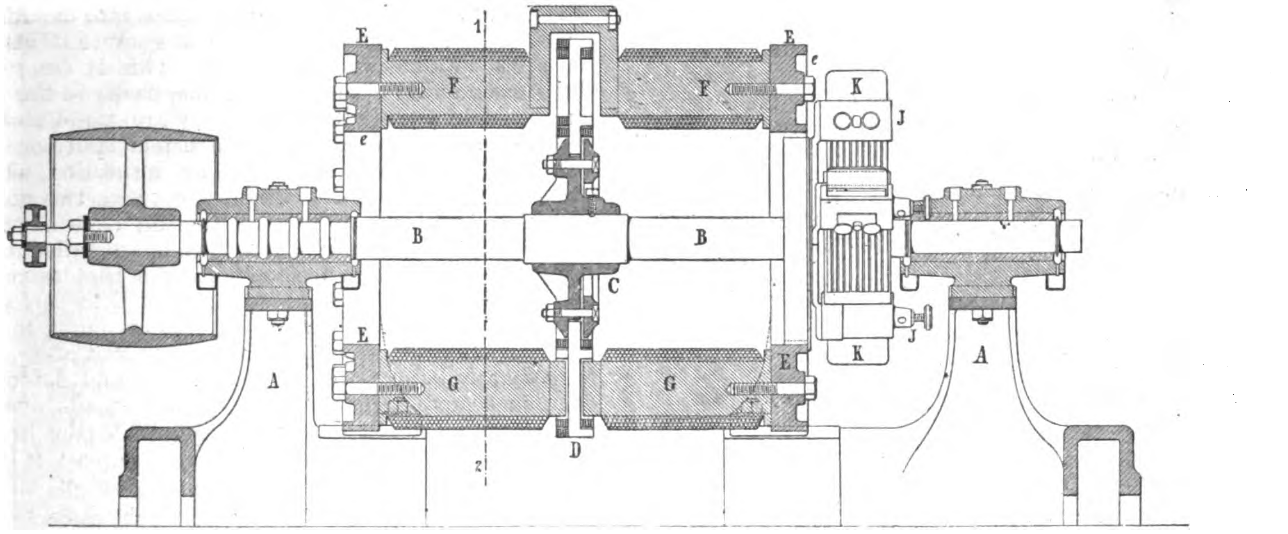


FIGURE 1.

In this manner all open and active north poles are on one side of the armature, and all open and active south poles are opposite to the first ones, on the other side of the armature. The inducing qualities concerning the generation of currents within the armature remain practically unaltered by this second mode of arranging the field magnets, as we will explain further on, but the stability of the machine with regard to its mechanical construction is much increased.

In order to remove the shaft, B, with armature, easily and without dismantling the whole machine, the standards, E E, are built open at the top at *ee*, and the openings are closed by removable segments, to which one or more of the field magnets are attached.

The most essential part of the machine, the armature disc, is constructed of straight radial parts, P, figure 3, and of parts R, figure 4 (both figures in elevation and plan), which latter are concentric to the shaft and shaped according to their relative distance from the centre. These parts, P and R, are all of copper. The concentric parts, R, have their ends bent at right angles to their planes, as shown in figure 4. Then P and R are connected as shown in figures 5, 6 and 7, in elevation, side view and plan; the different connections at *a*, *b* and *c* being made by riveting or by soldering. $P_{,}$ and $P_{,,}$ are the radial parts; $R_{,}$ and $R_{,,}$ are the concentric parts, the lengths of which must always cor-

respond to their relative distances from the centre, and to the angular distance between $P_{,}$ and $P_{,,}$. The end, *d*, of $R_{,,}$ is for the present free and without contact. Such a combination of two radial parts or strips with two concentric parts or strips may conveniently be termed an *element* of the armature, which element, instead of being built of four different pieces, could also be made partly or wholly of one piece of copper.

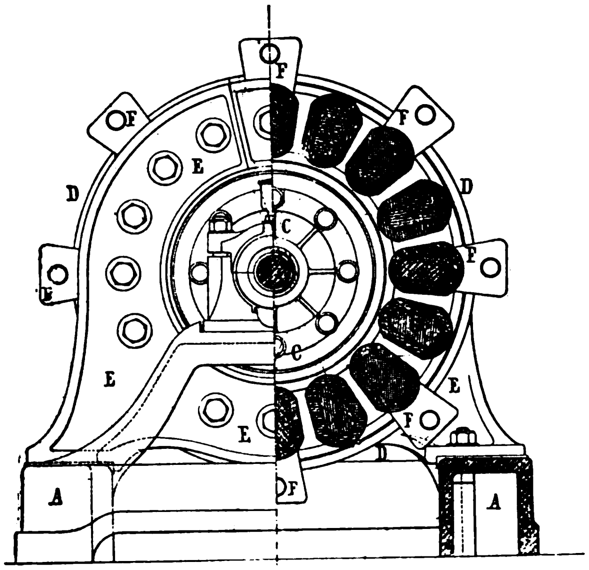


FIGURE 2.

A *second* element is then made, similar to the first one, but sufficiently smaller in the angular distance of its parts, P, and also correspondingly shorter in the lengths of the bent-up portions of its concentric parts, R, so that it may just be laid completely within the *first* element without touching anywhere except at *d*, where $R_{,,}$ of the first element is fastened, by riveting or soldering, to $P_{,}$ of the sec-

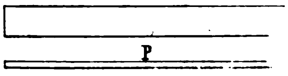


FIGURE 3.

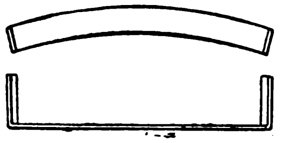
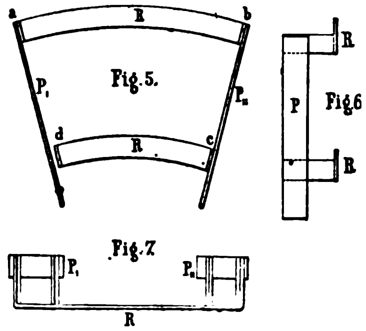


FIGURE 4.

ond. A similar *third* element is snugly laid within the second one, connecting and being in contact only through the end-point, *d*, of this latter. In the same manner a number of such elements, usually from five to six, are placed within each other, each one a little smaller than its



immediate predecessor; the concentric part, $R_{,,}$, however, being omitted with the last and innermost of these elements. The different elements are kept apart by narrow strips of some insulating material, which are laid between the radial parts at their ends, so that the air can circulate freely between all of the elements,

Such a combination or group of from five to six elements—forming a consecutive spiral course in a manner that a current, entering at $P_{,}$ of the first and outermost element, has to circulate through all of the elements one after the other, leaving at $P_{,,}$ of the last one—has been called by Mr. Bollmann a *sector* of the armature. It consists of from 10 to 12 radial parts, P, and of from nine to 11 parts, R.

The angular distance between the *medium* element of a sector must be equal to the angular distance from one pair of field magnets to the next following one, or with reference to the figures which show 16 pairs of field magnets, the medium angular distance of the elements of a sector must be equal in this case to the $\frac{1}{16}$ part of a circle. Each sector, therefore, will always be subjected to the simultaneous inductions of two succeeding pairs of magnets.

The armature disc is now composed of a number of such sectors. One-half of them is made shorter in the radial parts than the other half, and this leads to two distinct sets of sectors with reference to the positions of their parts, $R_{,}$ $R_{,,}$, from the centre. The rationale of this is readily understood when the different views of the armature disc are examined, as shown in figures 8, 9 and 10*a*. From figure 9 it will be seen that the radial parts of all the different sectors form one continuous lattice-like disc, and this packing or nesting of the sectors into one disc is only possible when the concentric parts, R, of the different sectors are able to pass each other without interference or mutual contact. By having them bent, as has been described, by arranging them at different radial distances, and by placing them sometimes behind and sometimes in front of the disc, as may be required and as shown in the drawings, this feat is accomplished. Sometimes, especially with large machines, it may be found convenient to make the sectors of more than two different lengths in their radial parts, which, of course, will then lead to more than two sets of concentric parts, $R_{,}$ $R_{,,}$.

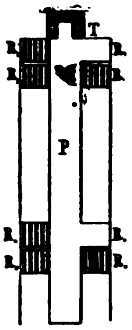


FIGURE 8.

Beginning in figure 9, to the left, the first two numbers, 1,1, represent the radial parts of a sector; the adjoining, next following sector is designated by 2,2; then comes sector 3,3, and finally sector 4,4. The sector which follows next to 4,4 is again numbered 1,1, because, according to the disposition of the drawing, this sector possesses exactly the same relative position to the field magnets as did the first sector, 1,1, and therefore it will, at all times and in all positions around the magnetic field, be similarly induced. This can be said of all sectors which are numbered 1,1; and, similarly, all sectors numbered 2,2 will always be simultaneously induced alike, and so on. The whole disc, therefore, consists of four different and distinct groups or series of sectors, for each of which the inductions will always be alike throughout, and any

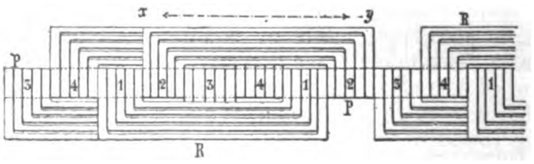


FIGURE 10*a*.

four consecutive sectors will always belong to these four distinct series.

Attention must here be called to a slight discrepancy in the drawings. In figures 10*a* and 8 the sectors are represented as consisting of five elements each, while in figure 9 the number of the elements in each sector is six. In the following we will assume each sector to contain five elements only.

The four series of sectors are connected into four separate circuits, and in figure 9 the connections for series 1

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are indicated. $P_{''}$ of the innermost element of a sector, connects with $P_{'}$ of the exterior element of the next following sector of the same series. The connecting pieces are placed within recesses of the clamping flanges, C, and cannot be seen in figure 1.

Each series, therefore, consists of eight sectors and 80 radial parts, P, and the whole disc is built altogether of 320 radial parts, P. The inductions in the four series follow one another, so that, while the induction is most intense in one of the series, two others are only partially induced, and the fourth is in a neutral position.

The disc is fastened to the shaft by the clamping flanges, C, as already described; but, in order to more firmly secure the different elements of the disc in their relative position to each other, an outer clamping ring, T, may be used, as shown in figures 8 and 9.

To obtain a most intense magnetic field the pole-pieces of the field magnets must approach the radial parts, P, as closely as possible; and it is also of importance that the concentric parts, R, be as close as possible to the pole-pieces, because useful currents are induced in both P and R. The pole-pieces are therefore arranged to project into the annular space formed by the concentric parts, $R_{'}$ $R_{''}$, and as shown in figure 1 at G G.

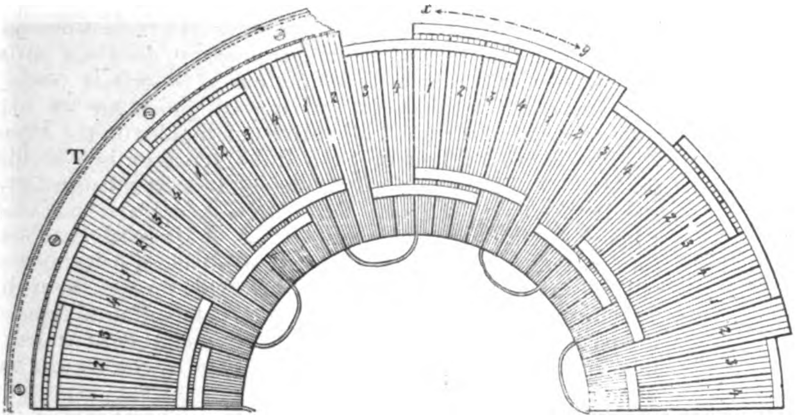

FIGURE 9.

The connections of the different series with the commutator may be made in different ways. For currents of low potential the two ends of each series may be led directly to the commutator, where connection is established with the external circuit as long as the potential of the induced currents in the armature is higher than that of the external main current. To secure good action the two potentials ought to be alike when the brushes make or break contact, and in order to accomplish this the brushes are made in pairs, which are adjustable, so as to cover a proper angular distance of the commutator. Two, and sometimes three, of the four series of the armature are simultaneously connected with the external circuit. For currents of low potential the pole-pieces should also be comparatively broad, whilst for currents of high potential the pole-pieces should be narrow, so as to concentrate the field. The different series may also be combined into one single continuous course, and branches be led off from it to the commutator, similarly to the connections of the ordinary Gramme ring. In such a case it is preferable to have more than four series in the disc, and this can be attained, for instance, by an arrangement of the sectors in the disc as exhibited in figure 10*b*. The length, *x y*, corresponds to the angular distance of two succeeding pairs of magnets. Only one-half of the radial parts, P, are shown in the drawing. The other half occupy the square places, which are left blank in the diagram for the sake of clearness. It will be noticed that there are now seven series in the disc, each of which may again be divided into two, if the field-magnets are chosen and distributed accordingly. The pole-pieces should then be made narrower, and fewer magnets (say from 10 to 12 pairs) ought to be used. The neutral zones are thus broadened, and sparks will be avoided at the commutator.

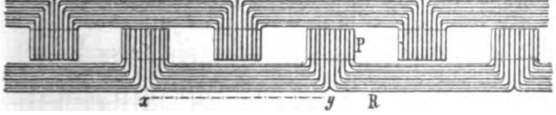

FIGURE 10*b*.

The commutator being of ordinary construction is of no particular interest.

Having thus described the essential parts of this new dynamo, it may be of interest to explain how the inductions actually do take place in the different conductors of the disc. To simplify matters we will assume the field magnets, instead of being arranged in a circle, to follow each other in a straight line; we will further assume the pole-pieces to be of a rectangular section, and we will move one single element along the line of the magnets, and observe in which manner its different parts are induced. The element in this case is supposed to be so constructed that its inner concentric part, $R_{''}$, instead of turning to the left of $P_{''}$, figure 5, is turning to the right. The diagrams in figures 11 and 12 illustrate this assumed state of affairs. The shaded rectangles represent the pole-pieces on one side of the armature, and facing the observer. South (*s*) and north (*n*) poles are following one another alternately, and the heavy zigzag line represents the moving element. The direction of the motion is from the left to the right, as indicated by the horizontal arrow.

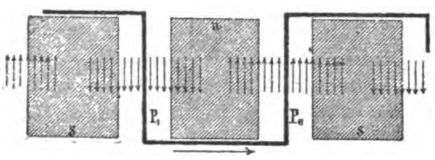

FIGURE 11.

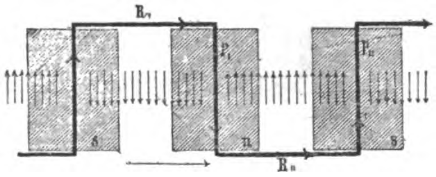

FIGURE 12.

According to the hypothesis of Ampère, a magnet can be substituted by electrical currents which encircle its axis, and this substitution can be adopted here the more readily, as we have only to deal with the external action of the field-magnets. Whatever be the true courses of these electrical currents, the directions of which are well known according to the polarity they are to represent, these courses must be coördinate to the central lines, *x x* and *y y*, figure 15. Decomposing the various elementary currents of the different courses into vertical and horizontal components, as shown in figure 15, for one course of a north pole and its analogous course of a south pole, and selecting four coördinately situated elements, *a*, *b*, *c*, *d*, and also

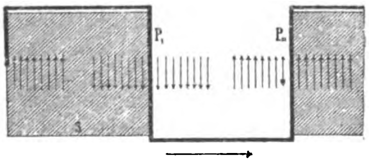

FIGURE 13.

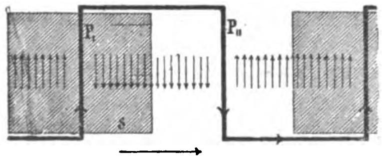

FIGURE 14.

$a_{,}$, $b_{,}$, $c_{,}$, $d_{,}$, of the currents, we find that we may substitute the rotary currents by two distinct sets of rectilinear currents, one of a horizontal, the other of a vertical, direction, We also find that all the vertical currents between a north and south pole are directed upwards when the south pole is to the right of the north pole; and all will flow downwards when the south pole is situated to the left of the north pole—we facing the poles. The horizontal currents, on the contrary, change their directions from pole to pole, and a little consideration will make it clear that they constantly neutralize themselves in their inductions upon the

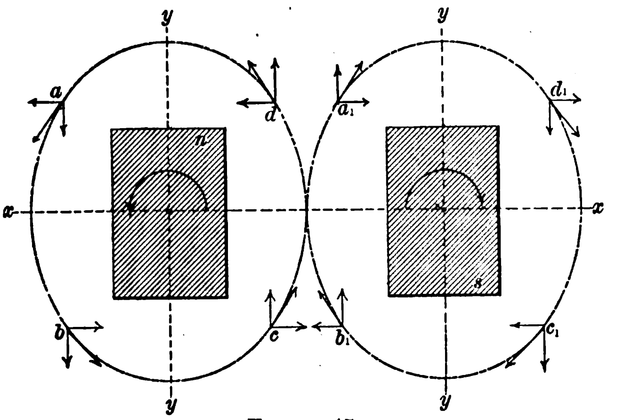

FIGURE 15.

moving element, as well with regard to the parts P as also concerning the parts R. The only currents which concern us, then, in the generation of useful inductions are those of a vertical direction, and these currents are indicated in their proper directions, in figures 11 and 12, by a number of vertical arrows.

In figure 11 the vertical parts, $P_{,}$ $P_{,,}$, are shown as occupying a central position between two succeeding field-magnets. By moving to the right, the part $P_{,}$ recedes from the electrical currents of the south pole on its left side, which are directed downwards, and this, according to the laws of electrical induction, induces in $P_{,}$ an equally directed current (downwards); but simultaneously $P_{,}$ approaches the electrical currents of the north pole on its right side, which are also directed downwards, and this induces in $P_{,}$ a current of contrary direction (upwards). The two induced currents being of opposite direction, and the two groups of electrical currents which induce them being of equal intensity (on account of the assumed central position of $P_{,}$), the inductions neutralize one another. This position of $P_{,}$, and also of $P_{,,}$, in which an analogous process takes place, is therefore a neutral one for $P_{,}$ and $P_{,,}$.

Before examining the inductions of $R_{,}$ and $R_{,,}$ we proceed to the position in figure 12. $P_{,}$ and $P_{,,}$ are passing the centres of the field magnets; $P_{,}$ is receding from the electrical currents on its left, all of which are directed downwards, and it is approaching the electrical currents on its right, all of which are flowing in an upward direction. Both of these groups of currents assist each other to induce a powerful current in $P_{,}$ of a downward direction; and in an analogous manner an upward directed current is induced in $P_{,,}$ at the south pole on the right. $P_{,}$ and $P_{,,}$ were moving from a neutral position into this one of most intense action; they now move on, the inductions diminishing gradually, to the next following neutral position, from which further on the inductions will again increase, though in a contrary direction.

Considering the position of the concentric part $R_{,}$, in figure 12, moving close to the pole-pieces, it will be observed that all the electrical currents between $P_{,}$ and $P_{,,}$ flow away from R′ in a direction at right angles, and this, according to the laws of induction, induces in $R_{,}$ a current of equal direction with the motion of the latter, which corresponds with the direction of the simultaneously induced currents in $P_{,}$ and $P_{,,}$. The same holds true of the induction in $R_{,,}$. If $R_{,,}$ was bent to the left, as in figure 5, the current would then be induced in an opposite direction to the motion of $R_{,,}$, but still in harmony with the currents in $P_{,}$, R, and $P_{,,}$.

By examining the element in different positions, relative to the field-magnets, it will be found that all the parts of an element of the armature are always induced alike. All elements, therefore, which have simultaneously the same relative position to the stationary field-magnets, and which elements are connected into one continuous course, will be traversed by induced currents of uniform direction, and generated in all of the different parts, P and R. Moving the elements gradually along the line of magnets neutral positions alternate with positions of most intense action, and with 16 pairs of field magnets, all of them having open poles, there will be 16 alternations of the currents in all parts of the disc during one turn of the shaft.

It remains yet to be explained why the new arrangement of the magnets with bridge-pieces, F, does not alter the manner and number of inductions as described above. Remembering that now all active south poles are on one side of the armature, and all active north poles on the other side, a glance at figures 13 and 14, representing acting south poles as facing us, will at once show that substantially the directions of the electrical currents are the same as when all poles were open and active. Figure 13, in which the element is in a central position between two acting poles, is again also a neutral position; while figure 14, in which $P_{,}$ is in the centre of an active pole, exhibits one of the positions of most intense action. The number of alternations of the current during one revolution of the disc is the same as before.

When considering the remarkable results obtained with the experimental machine, we find them to be due principally to the lengths, and to the ingenious and economic disposition of the copper conductors in the armature, so that all of the parts are usefully induced. Other important reasons will be found in the most intense magnetic field which is distributed over the entire disc; in the connection at the commutator of the several series of the disc in parallel, and in the total absence of iron in the armature, with its unavoidable coercive resistance, and consequent losses by radiation of heat.

United States patents have been allowed for Bollmann's dynamo, and will be published shortly.

ADDITIONAL DATA CONCERNING THE EXPERIMENTAL MACHINE.

It had 12 (not 16) pairs of field magnets, and they were all active, like G G, figure 1.

The width of the pole-pieces was $3\frac{3}{4}$ inches (95 mm.), and the intervening spaces were $2\frac{1}{8}$ inches (55 mm.), the measurements being taken at the outer circumference.

The magnets were in shunt connection, partly in parallel and partly in series. The weight of all the 24 magnets with windings was 685 lbs. (312 kilos). The total weight of copper in the armature was 66 lbs. (30 kilos), of which the inactive part between the flanges, C, weighed about 13 lbs., leaving, therefore, about 53 lbs. as the weight of the active conductors. The outside diameter of the disc was $23\frac{5}{8}$ inches (60 cm.), and its thickness between the pole-pieces was scant $\frac{1}{2}$ inch (12 mm). The elements were arranged to form four separate series. The total length of all radial parts $P_{,}$ $P_{,,}$, and all concentric parts, $R_{,}$ $R_{,,}$, in each series was 56 feet (17 m.), about one-half being absorbed by the radial, and the other half by the concentric parts. The four series were connected directly with the commutator in parallel. There were constantly two, and sometimes three, of the series in contact with the brushes, two, and sometimes one, being cut out. The internal resistance of the disc (two circuits being in parallel) was 0.002 ohm.

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APPLICATION OF ELECTRICITY TO HOROLOGY.

BY CHARLES A. TERRY.

(Concluded from page 171.)

III.

II. SECONDARY ELECTRIC CLOCKS OR DIALS.

In establishing an electric clock system, a series of secondary clocks or dials are electrically connected with a reliable central regulator or time-keeper, which may be either electrically or mechanically operated. The movements of the latter control the dials through the agency of electric impulses which it causes to traverse the connecting conductors. It is pertinent to the subject of secondary electric clocks, therefore, to speak of the devices whereby the actuating impulses are transmitted. One method is to oscillate a solenoid attached to the pendulum of the regulator, over the poles of a permanent magnet, as proposed by Mr. Wheatstone, and later by Mr. J. A. Stroh. The alternating electric impulses thus induced, actuate an astatic system of magnetic needles applied to each secondary clock. These are kept in continued rotation by the impulses, and their motion is communicated through their respective time-trains to the hands of the secondary clocks. The electric circuit is thus never interrupted in such a system. The impulses derived in this manner are of sufficient strength to actuate a very heavy pendulum, if rightly applied. The period of the pendulum must, of course, be very nearly the same as that of the impulses, or else the one a multiple of the other. An experiment made by Prof. Farmer about the year 1871, furnishes a striking illustration of the effect which may be, in this manner, produced by very weak currents. At that time two-second time signals or beats were transmitted from the Cambridge Observatory to a watchmaker's store in Boston. Prof. Farmer employed the receiving instrument as a relay for controlling the connections of a circuit through a pendulum bobbin of the character employed by Bain, Ritchie and others. (See figure 1, p. 91.) The relay served to complete a circuit through the bobbin or solenoid each two seconds, and an attractive force was thus periodically established between the solenoid and a permanent magnet over which it swung. With a battery of any considerable size it would, of course, be expected that the pendulum would at once respond. The battery which Prof. Farmer used consisted of four percussion caps, serving both as battery-cells and as copper plates, in each of which was placed a drop of solution of copper-sulphate and a zinc wire about $\frac{1}{16}$ of an inch in diameter. It required but a very few minutes for the impulses of this battery to establish the regular vibration of the pendulum, which weighed, say five or six pounds. The liability of other induced currents to be present upon the conductors, however, is a serious obstacle, which practically prevents the successful operation of a system organized upon the induced current principle. A better plan is to obtain the impulses by making and breaking the connections of a strong battery through the circuit leading to the secondary movements, as proposed, for instance, by Mr. Ritchie in 1872, and by these stronger impulses to maintain the movements of secondary pendulums which drive the clock movements. Both these methods, however, are applicable rather to synchronizing than to actuating pendulums. The plan usually adopted for operating the secondary movements is to obtain the periodic impulses by opening and closing the circuit of a battery by the movements of the prime regulator, and to drive each secondary movement by the vibrations of a pawl or an anchor driven to and fro by an electro-magnet included in the circuit. The impulses for driving the secondary clocks are usually transmitted each minute, second or half-second. It is customary to actuate the smaller dials every minute, while it is necessary, in operating the heavier movements, such as gallery dials and tower clocks, that the impulses should be more frequent; otherwise, the work to be performed by a single impulse would be excessive.

The more serious difficulties encountered in constructing circuit-closers for transmitting the impulses, arise from the destruction of the contact-points by the static discharge of the line and the liability of false contacts being made. To obviate this, attempts have been made to exclude oxygen from the points. William H. Hatcher, of England, in 1847, patented a circuit-closer consisting of an hermetically sealed glass vacuum tube, partly filled with mercury. Two platinum wires sealed into the tube constitute the terminals of the electric circuit. The tube, when rocked upon its transverse axis by the operation of the regulator, causes the mercury to complete the circuit periodically. An objection to the use of mercury as a circuit closing medium has always been found in its tendency towards oxidation or sublimation. By means of the vacuum tube Hatcher expected to overcome this difficulty. George S. Leclanché, in 1871, proposed a circuit-closer of this character, consisting of an hermetically closed glass tube divided into two compartments by a transverse partition, but communicating with each other through a narrow opening placed eccentrically. Each compartment is half filled with mercury, and the rotation of the tube carries the opening beneath the surfaces of the mercury, and thus places the mercury in the compartments in connection through the opening. In 1876 Mr. Davis, of Cleveland, patented a circuit-closer operating to complete the connections through metallic points, which the movements of the pendulum cause to dip into mercury submerged in kerosene or coal-oil. Charles Shepherd, in 1849, proposed to suspend a weight inside a sealed glass tube attached to the pendulum, the weight making alternate contact with platinum points introduced through the sides of the tube. The air was to be exhausted from the tube, or else to be replaced by hydrogen, and thus oxidation prevented. Experience has shown that the more desirable, as well as the more philosophical, plan is to remove the cause of the discharge, and thus of the oxidation at the points, rather than the means, and the open-air mechanical forms of circuit-closers, in connection with the various devices for preventing disruptive discharges, have come into more general use. It will not be expedient here to refer in detail to the numerous different forms of circuit-closers which have appeared at various times, further than to state that for the most part they have been constructed either upon the principle of revolving contacts passing beneath a contact surface, or a sliding contact-arm moved by a pendulum to and fro across contact-points, as illustrated in a patent of S. A. Kennedy, in 1867, or else by the direct impingement of one contact-point against another. Bain, it will be remembered, proposed to employ a non-conducting disc containing a series of metallic studs, which passed beneath a circuit-closing spring. The sliding or rubbing made in this manner is usually objectionable, for the reason that the presence of a particle of dust or oxide, or an uneveness in the contact surface, renders a succession of contacts very liable to occur, and a series of impulses to be transmitted instead of a single one. The direct impingement of one contact against another is usually considered the best plan to adopt. This may be accomplished by the impact of a contact-point upon the pendulum of the regulator against yielding arms extending into its path, as shown, for instance, in the U. S. patent of F. J. Ritchie, No. 143,847, of 1873, or by a contact-spring periodically pressed by the movements of the regulator against a stationary contact-arm or a second yielding contact spring. It has also been proposed to complete the circuit by the contact of the crutch-pin with one side of the aperture in the pendulum rod in which it works. The methods illustrated in figures 2 and 3 (pp. 169 and 170) have been found very excellent. It will be noticed that the circuits are, in these instances, closed through the impulse pawls, the regulators being themselves electrically actuated.

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However reliable the necessarily delicate contacts may be in other respects, they will become useless if exposed to repeated disruptive discharges which occur at the interruption of the circuit. Such discharges are due in part to the static capacity of the line wire, but to a great extent result from the inductive capacities of the electro-magnets in circuit. The occurrence of such discharges at the contact-points is to a great extent prevented, either by bridging the coils of the electro-magnets by resistance circuits or by substituting a second circuit for the circuit through the contact-points. In practice both methods are often resorted to. It is now customary, in certain clock systems, to place coils of fine wire in permanent circuits around the magnets, as shown in connection with the diagram, figure 3, of the primary clock. Among the best methods which have been suggested for substituting subsidiary circuits at the circuit-closing points, and thus affording a path through which the static discharges may take place, are those proposed by Mr. H. L. Bailey, by Mr. Himmer and by Mr. C. L. Clarke. According to Mr. Bailey's plan, a non-inductive shunt-circuit is completed after the actuating battery connections are formed, and it remains so completed a sufficient time after the separation of the delicate contact-points to allow the discharge to take place. The plan proposed by Mr. Himmer is to first complete the circuit-connections of the battery through an artificial resistance circuit, and to immediately afterwards temporarily substitute the clock circuit for the resistance circuit. The clock circuit remains closed, to the exclusion of the resistance circuit, a sufficient time to actuate the clocks. The resistance circuit is then again closed, and clock circuit opened, and finally the resistance circuit is again opened. The Clarke method is to close, by the operation of the delicate contact-points, a circuit through an electro-magnet adapted to operate heavier and stronger contacts, which serve to transmit the actuating current through the clocks. After all the instruments have operated the circuit is interrupted at a third contact point, which is specially constructed to withstand the detrimental effects of the disruptive discharges.

The secondary movements themselves vary principally in the method of applying the pawls and anchors to the driving-wheels of the time-trains. It is essential that the driving-wheels should not be liable to accidental displacement, and should not be advanced more than one tooth at each vibration of the anchor or stroke of the pawl, by reason of any unwonted force, such as might be occasioned by an increase in battery strength; on the other hand, there never should be a failure of the wheel to advance its regular distance. The latter end is more easily attained than the former, which has called forth various systems of locking pawls. A simple vibrating anchor, having driving-pallets, operates, in many instances, very successfully, though the difficulty of locking the movement when the hands are at rest is an objection. Messrs. Edmands and Hamblet, in 1868, described a driving anchor, having peculiarly formed driving-pallets, in connection with two locking pawls, one engaging a ratchet-wheel secured to the driving-wheel arbor, when the anchor is at the left hand, and the other when it is at the right. Mr. A. S. Crane, of Newark, in 1883, planned a somewhat novel relation between the angles of the teeth and the driving pallets of the anchor, which proved to be advantageous. At about the same time he modified the well-known metronome escapement for the purpose of propelling the wheels, and this proves also a very effective device for actuating the secondary movements. One other movement, possessing the double merit of being ingenious and useful, should be mentioned. It is that patented by Mr. A. W. Gray in 1883. It consists of a pawl pivoted in an armature-lever in such manner that it is first carried by the latter in a radial direction towards the centre of the driving-wheel into engagement with the teeth of the wheel. An arm or right-angled extension of the pawl then strikes a fixed stop, causing the end of the pawl between the teeth to move in a tangential direction, with reference to the wheel, which is thus advanced. The return movement of the lever withdraws the pawl, which, upon the next forward movement, enters between the succeeding teeth and repeats the operation.

Mr. L. H. Spellier, in 1882, patented a noiseless secondary clock. He makes use of a circular armature or range of armatures carried upon a star wheel, which is advanced step by step, partly by the action of an electro-magnet, and partly by the operation of a weighted lever. The electro-magnet advances the wheel until two armatures confront its poles, and when in this position a small roller upon the weighted lever presses against the face of one of the teeth near its apex. Upon the interruption of the circuit, the electro-magnet being demagnetized, the lever and roller advance the wheel still further.

III. SYNCHRONOUS PENDULUMS.

One method of maintaining several independently actuated clocks in unison with each other, is to cause their pendulums to vibrate synchronously. It is necessary that the normal periods of the pendulums should either be approximately equal or multiples of each other and that there should be some standard controller or regulating pendulum. A very slight force, if rightly applied, is sufficient to govern the movements of a pendulum tending to vibrate in periods approximately the same as the recurrence of the force. The subsidiary pendulums may be constructed to vibrate in slightly shorter periods than the regulating pendulum and be caused to move slowly by some retarding influence controlled by the latter, or they may be adjusted to vibrate in as nearly as possible the same periods, and an accelerating or retarding force applied thereto accordingly as they lag behind or gain upon the regulator. In 1869 H. W. Cook described in an English patent a clock-system regulated upon the principle of retardation. The clocks were adjusted to gain, and the pendulums were caught at the ends of their beats by an electro-magnet and released at the proper instant by the controlling clock which operated to break the circuit. Giovanni Casselli, of Switzerland, in 1863, also obtained synchronism of pendulums for the purposes of autographic telegraphy, in essentially the same manner. The method more frequently employed, however, is that of either retardation or acceleration as the case may require. This was accomplished by some of the earlier inventors of electric clocks, and one method was fully described by Bain. Other adaptations were made by Wilson, Ritchie and Kennedy, and later by Mr. Bailey and Mr. Himmer. The earlier plan was to cause a permanent magnet to swing into and out of a stationary solenoid at each vibration of the regulating pendulum. Should the vibrating magnet be slightly behind, at the instant the current traversed the solenoid, the tendency would be to accelerate its motion. On the other hand, should it be in advance its tendency is to retard. It is now preferred to place electro-magnets at the limits of the pendulums' vibration and to cause them to act upon soft iron armatures carried upon the pendulums. Mr. Bailey's invention consisted essentially in organizing a system of circuits which prevented the current from being transmitted through the regulating magnets so long as the pendulums beat in unison. Any acceleration or retardation on the part of any pendulum, caused the magnet of that particular pendulum to be brought into circuit, and the attraction which it exerted upon the armature to retard or hasten its movement accordingly. Mr. Himmer's plan was to send alternating currents through the regulating magnet so that any tendency of the magnets to become permanently magnetized were avoided.

IV. CORRECTING DEVICES.

One of the methods proposed for correcting the position of the minute-hand of a clock, which has already been referred to in connection with the Barwise and Bain inven-

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tions of 1841, is to grasp the hand at the proper moment by two pivoted clips, which move it either backward or forward a slight distance as the case may require. The means for carrying out this method has been variously modified. George Lund, of London, about the year 1877, invented certain improvements relating especially to the means for actuating the arms or clips. Mr. Hamblet, in 1882, proposed to operate one of the clips by means of a rack-bar attached to an armature lever and engaging a pinion upon the arbor of that clip. The second clip is geared to and thus moves with the first. This class of device was widely advertised and extensively introduced in England. The clocks employed at the stations of the elevated railways of New York, are equipped with synchronizing devices, furnished by the Standard Time Co., and constructed upon this general plan. Although the clocks are thus equipped, we understand that in practice they are not considered necessary, for the time kept by the clocks is sufficiently accurate without resorting to them.

Another method of correcting the hand is to construct the hand itself of iron or steel, and place an electro-magnet behind the dial at the point where it is desired to set the hand. An electric impulse transmitted through the magnet at the proper instant serves to advance the hand or move it backward. Such a device was invented as early as 1847 by Mr. W. H. Hatcher, who has been before referred to.

The next class of hand correcting devices to be noticed are those in which an arm or cam is attached to the arbor of the minute hand, and this is turned back or forward by a lever operated by an electro-magnet. The principle is very simple and when once suggested admitted of improvement only in minor details of construction. In 1853 it was suggested in a provisional patent granted to E. Dobell, of Hastings, England, that the minute hand of a clock movement be freed from the train at the proper moment by an electro-magnet and set in position by a wedge inserted in a recess formed in a disc upon the minute-hand arbor. Mr. Himmer and others employ a heart-shaped cam, which is capable of turning the arbor one-half a revolution in either direction and thus correcting very great errors. Mr. A. A. Knudson, of Brooklyn, in 1882, patented a combined printing-telegraph instrument and clock in which the setting device consisted of a straight bar attached to the arbor and engaged by a forked arm under the control of an electro-magnet. The forked arm normally stands out of the range of the armature lever of the electro-magnet, but is thrown into the path by the operation of the clock. M. Breguet, in 1857, patented in France a clock mechanism wherein an independent train was employed for synchronizing the hands. This train was released at a predetermined time, and when so released set the hands. R. W. Willson, of New Haven, in 1883, patented a somewhat similar organization containing the additional feature of means for automatically arresting the movement of the synchronizing mechanism when the hands have been set, irrespective of the duration of the current setting the mechanism in operation.

An English patent granted to Wm. S. Harrison in 1868, contained a description of an apparatus for setting the hour, minute and second hands either backward or forward to the exact time. During the five seconds preceding the time which the clocks are to be set to indicate, a cam on the minute-wheel of the regulator completes the circuit through an electro-magnet in each subsidiary clock. These detach the hands from the driving mechanism and unlock a special movement. The minute-hand is set by a pin upon its wheel engaging a lever operated by the special movement and the second wheel is set by a lever and a heart-shaped cam.

It will be noticed that the synchronizing devices are brought into requisition not more frequently at the most than once an hour and usually only once in 12 hours. This fact has given rise to the devising of means for permitting the line wires to be employed at other times for other purposes. The French patent of M. Breguet of 1857, describes a hand-setting apparatus consisting of two revolving discs, each containing a projecting pin which engages upon the corresponding side an arm projecting radially from the minute-hand arbor. If the hand be too fast one pin sets it back and if too slow the other pin sets it forward. The discs revolve a sufficient distance to bring the pins out of the path of the arm immediately after the setting is accomplished. The discs are driven by an independent train released by an electro-magnet. Mr. Dobell, whose invention has been already referred to, proposed in his provisional patent to use the wires leading to the setting device at other times for general telegraphic purposes, and to automatically connect the setting devices in circuit at the proper periods. Mr. J. F. Kettell, of Worcester, in 1883, patented certain improvements in apparatus for setting in operation the independent train for operating the setting device, and connecting and disconnecting the apparatus from circuit when the synchronizing apparatus was not released, so that the line might be employed for other purposes such, for instance, as telegraphy.

We have now considered the more important methods of employing electricity for assisting in indicating time. Certain other branches of the general topic, such as the transmission of time signals, the releasing of time-balls and the operation of striking mechanism, it has not been the purpose of this article to discuss.

"ON THE CHANGES PRODUCED BY MAGNETIZATION IN THE LENGTH OF RODS OF IRON, STEEL AND NICKEL."[1]

BY SHELFORD BIDWELL, M.A., LL.B.

THE earliest systematic experiments on the effects produced by magnetization upon the length of iron and steel bars are those of Joule, an account of which is published in the *Phil. Mag.* of 1847. Joule's experiments have many times been repeated, and his general results confirmed. In particular, Prof. A. M. Mayer carried out a series of very careful observations with apparatus of elaborate construction and great delicacy. The conclusions at which he arrived were in accord with those of Joule, so far as regards iron; in the case of steel there was some apparent discrepancy, which, however, might to a great extent be accounted for by differences in the quality of the metal used, and in the manner of conducting the experiments. In 1882 Prof. Barrett published in *Nature* an account of some experiments which he had made, not only on iron but also on bars of nickel and cobalt, with the view of ascertaining the effect of magnetization upon their length.

The knowledge on the subject up to the present time may be summarized as follows :—

1. Magnetization causes in iron bars an elongation, the amount of which varies up to a certain point as the square of the magnetizing force. When the saturation point is approached the elongation is less than this law would require. The effect is greater in proportion to the softness of the metal.

2. When a rod or wire of iron is stretched by a weight, the elongating effect of magnetization is diminished; and if the ratio of the weight to the section of the wire exceeds a certain limit, magnetization causes retraction instead of elongation.

3. Soft steel behaves like iron, but the elongation for a given magnetizing force is smaller (Joule). Hard steel is slightly elongated, both when the magnetizing current is made and when it is interrupted, provided that the strength of the successive currents is gradually increased (Joule). The first application of the magnetizing force causes elongation of a steel bar if it is tempered blue, and retraction if it is tempered yellow : subsequent applications of the *same* external magnetizing force cause temporary retraction,

1. Abstract of paper read at the Meeting of the Royal Society, April 23d, 1885.

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whether the temper of the steel is blue or yellow (Mayer).

4. The length of a nickel bar is diminished by magnetization, the maximum retraction being twice as great as the maximum elongation of iron (Barrett).

In order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetizing forces with which they worked. From data contained in their paper, it was calculated that the strongest magnetizing force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetizing force was carried up to about 312 units. The metal rods, too were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten-millionth part of this length.

By using thinner iron rods and greater magnetizing forces than those previously employed, the following curious and interesting fact was established. If the magnetization be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetizing force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetization; and if the magnetization be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetizing force in a thin iron rod was greatly reduced by stretching; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetizing forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetization of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalize from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetizations referred to are temporary only; before the beginning of an experiment the rod was permanently magnetized by passing through the magnetizing coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetization was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one twenty-fifth part of the whole.

I. IRON.

1. The length of an iron rod is increased by magnetization up to a certain critical value of the magnetizing force, when a maximum elongation is reached.

2. If the critical value of the magnetizing force is exceeded, the elongation is diminished until with a sufficiently powerful magnetizing force the original length of the rod is unaffected, and if the force is still further increased the the rod undergoes retraction. Shortly after the critical point is passed, the elongation diminishes in proportion as the magnetizing force increases. The greatest actual retraction hitherto observed was equal to about half the maximum elongation, but there was no indication of a limit, and a stronger magnetizing force would have produced further retraction.

3. The value of the external magnetizing force corresponding to maximum elongation is for a given rod, approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetization of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetizing force.

4. The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

5. The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

6. The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetizing force when the rod is stretched than when it is unstretched.

II. STEEL.

7. In soft steel magnetization produces elongation, which, as in the case of iron, increases up to a certain value of the magnetizing force, and afterwards diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

8. The critical value of the magnetizing force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetizing force is a minimum; in steel of a yellow temper the value of the critical magnetizing force is lower than in steel, which is either softer or harder.

9. In soft steel a strong magnetizing force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

10. A temporary elongation when once produced in soft steel may be maintained by a magnetizing force which is itself too small to originate any perceptible elongation.

III. NICKEL.

11. Nickel continues to retract with magnetizing forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

12. A nickel wire stretched by a weight undergoes retraction when magnetized.

THE MISSING CABLE STEAMER.

The new steamer Magneta, recently constructed especially for the laying and repairing of cables, is now supposed to have been lost with all on board. She left the Thames for Singapore early in March, and has not been heard from since leaving the Channel. One of her boats was seen 200 miles off Cape Finisterre, on the northwest coast of Spain. It appeared to have been properly lowered, but there was no apparent evidence of its having been occupied. She was a sister vessel to the Electra, and both were constructed upon the most approved plans, and supposed to be as thoroughly capable of weathering any storm as it is possible to build a ship. The fact that her boilers were of steel brings up the question as to the adaptability of this material for such purposes. The failure of a new steel boiler, under a hydraulic pressure of 240 pounds pressure, has led to an investigation, under the direction of Lloyd's Register, of the process of manipulation of the plates. Mr. Parker, who conducted this examination, is of the opinion that the plates are injured by unequal heating.

In commenting upon this important question, the *English Mechanic* says that there is at least ground for suspicion that not only the Magneta, but other missing steamers have foundered in consequence of boiler explosions.

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ON THE RESISTANCE OF PURE COPPER WIRE.

BY GEO. B. PRESCOTT, JR.

SEVERAL years ago Mr. Sidney B. Paine prepared a table giving the electrical resistances of pure copper wires drawn to the Brown & Sharpe, or so-called American gauge, which proved to be of considerable practical convenience to electricians generally, and especially to those engaged in electric lighting. So far as I am aware, it is the only one of the kind in common use in the United States to-day. The basis for the calculations in this table was that a pure copper wire, one foot long and one mil diameter, has 10.8 ohms resistance at 75° F., or, to express it more conveniently, $R_{ft.} d^2 = 10.8$. As Mr. Paine omitted to state how or where he procured this standard, it is to be presumed that he determined it experimentally. According to Dr. Matthiessen,[1] the resistance of one English mile (5,280 feet) of chemically pure copper wire $\frac{1}{16}$ inch (62.5 mils) in diameter, at the temperature of 15.5° C. (59.9 F.), is 13.59 ohms, which is equivalent to $R_{ft.} d^2 = 10.381$. This value was arrived at by means of an exhaustive series of experiments on samples of copper procured from various parts of the world, and has been generally referred to as a standard. I know of no other authoritative determination of the specific resistance of copper, nor have I ever heard any doubts expressed as to the correctness of Matthiessen's figure, excepting to the effect that, if anything, it appears to be a trifle *too high*. I have myself tested specimens of copper wire having, on Matthiessen's basis, a conductivity of a fraction over 100 per cent., and have thought the discrepancy might be due to the superior methods of working and drawing copper now in vogue. It will be seen from the figures given above that there is a difference of about four per cent. between Matthiessen's and Paine's determinations; and as the latter's figure is even *higher* than Matthiessen's, it is extremely improbable that it can be correct, and there certainly appears to be no reason for accepting it. Assuming Matthiessen's figure, Paine's table is right for wire at the temperature of 94° F., which is too high, however, to be of much practical utility.

The following table is calculated on the basis of Matthiessen's standard, and sufficiently explains itself:

WESTON LABORATORY, NEWARK, N. J.,
May 11, 1885.

1. Report of the British Association Committee on Electrical Standards, 1873.

TABLE OF DIMENSIONS AND RESISTANCES OF PURE COPPER WIRE.*

American Gauge, Brown & Sharp Number.	Diameter. Mils.	Area.		Weight & Length sp. gr. ·8·9.			Resistance @ 75° F.				Log d^2.	Log R.
		Circular mils (d^2) 1 mil = ·001 in.	Square in. (d^2 × ·7854.)	Lbs. per 1000 ft.	Pounds per mile.	Feet per lb.	R. Ohms per 1000 feet.	Ohms per mile.	Feet per Ohm.	Ohms per lb.		
0000	460·000	211600·00	166190	639·33	3375·7	1·56	·04906	·25903	20383·	·000076736	5·3255157	$\bar{2}$·6907235
000	409·640	167805·00	131790	507·01	2677·0	1·97	·06186	·32664	16165·	·00012039	5·2248000	$\bar{2}$·7914392
00	364·800	133079·40	104520	402·09	2123·0	2·49	.07801	·41187	12820·	·00019423	5·1241128	$\bar{2}$·8921264
0	324·950	105592·50	82932	319·04	1684·5	3·13	·09831	·51909	10409·	·00030772	5·0236310	$\bar{2}$·9926082
1	289·300	83694·20	65733	252·88	1335·2	3·95	·12404	·65490	8062·3	·00048994	4·9226953	$\bar{1}$·0935439
2	257·630	66378·00	52130	200·54	1058·8	4·99	·15640	·82582	6393·7	·00078045	4·8219914	$\bar{1}$·1942478
3	229·420	52634·00	41339	159·03	839·68	6·29	·19723	1·0414	5070·2	·0012406	4·7212664	$\bar{1}$·2949728
4	204·310	41742·00	32784	126·12	665·91	7·93	·24869	1·3131	4021·0	·0019721	4·6205733	$\bar{1}$·3956659
5	181·940	33102·00	25998	100·01	528·05	10·00	·31361	1·6558	3188·7	·0031361	4·5198542	$\bar{1}$·4963850
6	162·020	26250·50	20617	79·32	418·81	12 61	·39546	2·0881	2528·7	·0049868	4·4191300	$\bar{1}$·5971092
7	144·280	20816·00	16349	62·90	332·11	15·90	·49871	2·6331	2005·2	·0079294	4·3183973	$\bar{1}$·6978419
8	128·490	16509·00	12966	49·88	263·87	20·05	·62881	3·3201	1590·3	·012608	4·2177208	$\bar{1}$·7985184
9	114·430	13094·00	10284	39·56	208·88	25·28	·79281	4·1860	1261·3	·020042	4·1170723	$\bar{1}$·8991669
10	101·890	10381·00	8153·2	31·37	165·63	31·38	1·	5·2800	1000·0	·031380	4·0162392	0·0000000
11	90·742	8234·00	6467·0	24·88	137·37	40·20	1·2607	6·6568	793·18	·050682	3·9156109	0·1006283
12	80·808	6529·90	5128·6	19·73	104·18	50·69	1·5898	8·3940	629·02	·080585	4·8149065	0·2013327
13	71·961	5178·40	4067·1	15·65	82·632	63·91	2·0047	10·585	498·83	·12841	3·7141956	0·3020436
14	64·084	4106·80	3146·9	12·41	65·525	80.59	2·5908	13·680	385·97	·20880	3·6027977	0·4134415
15	57.068	3256·7	2557·8	9·84	51·956	101·63	3·1150	16·477	321·02	·31658	3·5127778	0·4934614
16	50.820	2582·9	2028·6	7·81	41·237	128·14	4·0191	21·221	248·81	·51501	3·4121076	0·6041316
17	45·257	2048·2	1608·6	6·19	32·683	161·59	5·0683	26·761	197·30	·81900	3·3113724	0·7048668
18	40·303	1624·3	1275·7	4·91	25·925	203·76	6·3911	33·745	156·47	1·3023	3·2106662	0·8055730
19	35·390	1252·4	983·64	3·78	20·051	264·26	8·2889	48.765	120·64	2·1904	3·0977431	0·9184961
20	31·961	1021·5	802·28	3·09	16·315	324·00	10·163	53·658	98·401	3·2926	3·0092384	1·0070008
21	28·462	810.10	636·25	2·45	12·936	408·56	12·815	67·660	78·037	5·2355	2·9085386	1·1077006
22	25·347	642 70	504·78	1·94	10·243	515·15	16·152	85·283	61·911	8·3208	2·8080083	1·2082309
23	22·571	509·45	400·12	1·54	8·1312	649·66	20·377	107·59	49·087	13·238	2·7071016	1·3091376
24	20·100	404·01	317·31	1·22	6·4416	819·21	25·695	135·67	38·918	21·050	2·6063921	1·4098471
25	17·900	320·40	251·64	·97	5·1216	1032·96	32·400	171·07	30·864	33·466	2·5056925	1·5105467
26	15·940	254·01	199·50	·77	4·0656	1302·61	40·868	215·79	24.469	35·235	1·4048508	1·6113884
27	14·195	201·50	158·26	·61	3·2208	1642·55	51·519	272·02	19·410	84·644	2·3042751	1·7119641
28	12·641	159·79	125·50	·48	2·5344	2071·22	64·966	343·02	15·393	134·56	2·2035496	1·8126896
29	11·257	126·72	99·526	·38	2·0064	2611·82	81·921	432·54	12·207	213·96	2·1028452	1·9133940
30	10·025	100·5	78·933	·30	1·5840	3293·97	103·80	545·39	9·6812	340·25	2·0021661	2·0140731
31	8·928	79·71	62·604	·24	1·2672	4152·22	127·27	671·99	7·8573	528·45	1·9015128	2·1047264
32	7·950	63·20	49·637	·19	1·0032	5236·66	164·26	867·27	6·0880	860·33	1·8007171	2·2155221
33	7·080	50·13	39·372	·15	·7920	6602·71	207·08	1093·4	4·8290	1367·3	1·7000977	2·3161415
34	6·304	39·74	31.212	·12	·6336	8328·30	261·23	1379·3	3·8281	2175·5	1·5992279	2·4170113
35	5·614	31·52	24·756	·10	·5280	10501·35	329·35	1738·9	3·0363	3458·5	1·4985862	2·5176530
36	5·000	25.000	19·635	·08	·4224	13238·83	415·24	2192·5	2·4082	5497·4	1·3979400	2·6182992
37	4·453	19·83	15·567	·06	·3168	16691·06	523·76	2765·5	1·9093	8742·1	1·2971037	2 7191355
38	3·965	15·72	12 347	·05	·2640	20854·65	660·37	3486·7	1·5143	13772·	1.1964525	2·8197867
39	3·531	12·47	9·7939	·04	·2112	26302·23	832·48	4395·5	1·2012	21896·	1·0958665	2·9203727
40	3·144	9·89	7·7676	·03	·1584	33175·94	1049·7	5542·1	·9527	34823·	0·9951963	3·0210429

*Calculated on the basis of Dr. Matthiessen's standard, viz.: 1 mile of pure copper wire of $\frac{1}{16}$ in. diam. equals 13·59 ohms at 15·5° C. or 59.9° Fahr.

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THE RAILWAY SIGNAL DECISION.

BY JOSEPH P. LIVERMORE.

THE Supreme Court has recently rendered a decision which may be of considerable interest to electrical inventors and owners of patents on electrical apparatus.

But comparatively few cases on electrical patents have recently come before the Supreme Court, and it is interesting to learn what will be its treatment of such cases. If the decision referred to is to be followed, electrical patents will be of but little value.

The subject-matter of the case in question, and the relation of the patented apparatus to that used by the defendant is clearly shown in the following diagrams. Figure 1 represents the apparatus on which complainant's patent was granted.

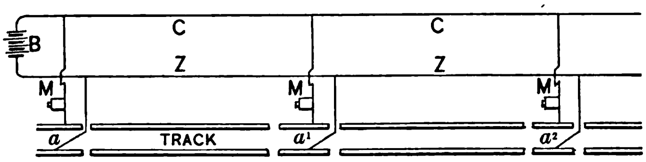

FIGURE 1.

The object of the invention is to operate a number of railway signals on what is known as the "block-system" from a single battery, instead of using a separate battery for each block of the track and its signals, as had been previously practiced. To accomplish this, the inventor extends from the battery, B, two main conductors, C and Z, and at each of the block sections or points where the signals are to be operated, these conductors are connected with normally open branches as shown, including electro-magnets, M, which operate or control the signals. The branches contain circuit-closers operated by the train, so that when a train passes a given one, the branch is closed automatically, the electro-magnet energized, and the signal or signals controlled by it are operated. The circuit-closer shown and described in the patent consists of a pair of opposite rails insulated from one another and from the rest of the track and connected with the terminals of the branch-circuit, so that when the wheels and axles of the train pass over these rails they complete the branch-circuit and thus cause the magnet to be energized. Figure 2 represents the

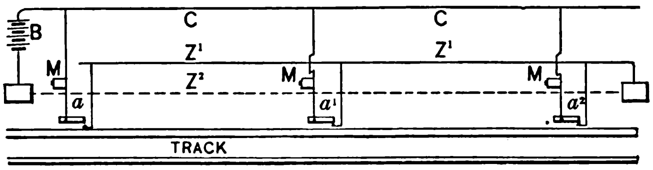

FIGURE 2.

defendant's apparatus, the same letters being used to indicate the corresponding parts. It differs from the complainant's apparatus in that instead of using a wholly metallic circuit one pole of the battery is grounded, and a wire, Z^1, open or insulated near the battery, extends along parallel with the main wire, C, and is grounded at the end of the series of signals remote from the battery. The signal magnets, M, are in normally open branches between the wires C and Z^1, and it will be seen that the wire Z^1 with the earth-return, represented at Z^2, forms a conductor from any of the branch-circuits to one pole of the battery, thus corresponding in function to the main wire Z of figure 1. Another difference between the two devices is that the circuit-closers A A^1, figure 2, used by defendant were of a peculiar construction invented by him, but belonging to the general class that are operated by the action of the wheels of the trains on one end of a lever or treadle. It may be stated here, although not alluded to especially in the decision, that both kinds of circuit-closers were known in connection with railway signal apparatus long before the patent, although defendant's circuit-closer, as before stated, contains some novel features in the minor details of construction. With regard to the circuit-closers the patentee makes the following statement in his specification :

> I do not desire to confine myself to the use of any particular form of visual or audible signals, nor to the particular devices herein described for closing the electric circuit at points from which a signal is to be operated. Instead of the circuit being closed automatically by the train itself, it may be closed by a signalman by means of a key or switch, or otherwise.

His first claim is as follows :

> The battery B in combination with the positive and negative conductors C and Z, two or more electro-magnets M, M^1, M^2 for actuating or causing to be actuated visual or audible signals, and two or more circuit-closers, a, a^1, a^2, placed at intervals along the line of a railroad, substantially as and for the purpose specified.

The Court decided that the apparatus, shown in figure 2, does not infringe the above claim in view of the differences in construction and arrangement that have already been mentioned in describing figure 2, and which were considered by the Court to be material and substantial. The decision admits the validity of the patent and of the claim above cited, but asserts that either one of the differences above referred to namely, the difference in the circuit-closers, or the difference in the main circuits, alone is sufficient to avoid the patent or remove defendant's apparatus from the scope of the claim.

In referring to the difference in the circuit-closers the Court first states that the patent is merely for a new combination of old well-known devices, the separate elements of which were not claimed by the patentee, and that consequently "to constitute identity of invention and therefore infringement not only must the result attained be the same, but the elements combined in both cases must be the same and combined in the same way so that each element shall perform the same function ; provided, however, that the differences alleged are not merely colorable according to the rule forbidding the use of known equivalents."

The Court then decides that the insulated sections of the rails as circuit-closers constitute an essential element in the combination described in the patent, and that the difference between them and the lever or treadle-circuit-closer is material. In referring to the phrase above quoted from the patent that "the circuit may be closed by a signalman by means of a key or switch or otherwise," the Court states that the only alternatives proposed have reference not to a substitute for the insulated track-sections "but merely to another mode of using them in closing the circuit." It is interesting to attempt to picture what the Court had in mind in making this statement ; or to try to graphically represent the Court's conception of a key or switch for closing the branch-circuits in figure 1, that would still involve the rail sections as essential to the operation ; or to explain how the Court thought the *rails* were to be used in closing the branch circuits by a *key* or *switch*. The language of the decision, after referring to the fact that the circuit-closers A, A^1, A^2, are expressly named as a part of the combination, is as follows : "The use of insulated sections of the railroad track thus repeatedly appears in every part of the specifications as an unchangeable and characteristic feature of the invention, and there is nothing in the state of the art at that date, as disclosed in the evidence, to show that the patentee would have been justified in applying, or that, if he had applied, an application would have been sanctioned by a grant of a patent, for a combination as large and undefined as that now claimed by implication and construction, so as to cover every form of a circuit-closer then known or thereafter invented ; for that employed by the defendants as part of the Hall system was not only not known and in use at the

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date of the patent, but was a device invented by Hall himself or one by Snow, for which the latter obtained a patent dated October 21, 1873. It dispenses altogether with the use of insulated sections of the track, and employs instead a separate instrument placed near the track, and worked by means of a lever connected with the track, so that the wheels of locomotives and cars passing on the track depress the outer end, the lever being raised again and held up after the train has passed by means of a spring, which holds it in place."

It has been tacitly acknowledged in the decision, or at any rate no evidence is cited to the contrary, that the result of operating a number of signals from a single battery was novel, and no doubt is raised as to the validity of the combination claim; Why then should the inventor be restricted to the precise construction of *each element* of the new combination? There was no more novelty in using the rails for the circuit-closer than in using any other form of circuit-closer known at that time in combination with the other elements, and there is no intimation that the rail circuit-closer produced any different effect on the other elements of the combination from what would be produced by any other circuit-closer then known, as in point of fact it did not. If the principle holds that a claim containing as an element of combination "a circuit-closer" does not cover every form of circuit-closer that is suitable for performing the same function in the combination, then an inventor in order to afford himself even a moderate chance of protection for a new combination, will be obliged to take a separate patent to cover each and every form at that time known of each element of his combination in connection with the other elements. In other words suppose there were a hundred or a thousand different varieties of circuit-closers, to be operated automatically by passing trains, in existence at the time he made his invention, he would have to take first a hundred or a thousand different patents each one illustrating and claiming a different one of the said circuit-closers in combination with his other elements B, C, Z and M; and following the doctrine of the Court, it would be just as reasonable to take the elements C and Z, or his line-wires, and take a separate patent for every different way in which they may be supported and insulated, and then take his element B and run through all the different batteries that are known to mankind; for no reason is given or can be suggested why the invention should be limited to the precise construction of the circuit-closer, any more than to the precise construction of each and every other element of the combination, except possibly that the patentee, probably believing that railway track circuit-closers were somewhat less known to the public than batteries and line-wires, took a little more pains in explaining the construction of one which he believed would operate satisfactorily, it being fair to assume that if he had indicated his circuit-closer by a conventional diagram just as he did his battery the Court would not have limited him with regard to his circuit-closer any more than it did with regard to the battery. The patentee who, as an examination of the evidence shows, had had considerable experience in railway signals and found that grounded circuits did not always operate satisfactorily, was also unfortunate enough to give the public the benefit of his experience by stating that the conductors C and Z should be insulated from the ground and from each other. In view of this statement the Court also decides that defendant by using the ground as a part of his circuit with the different arrangement previously referred to, did not use the conductors C and Z of the patent and consequently did not infringe. On this point the defendant introduced expert testimony to show that his part wire and part ground circuit was superior to the wholly wire circuit, because the different circuits completed by closing the different branches are all of the same length or resistance—including the conductor C, up to the branch in question and then the conductor Z^1 to the remote end of the line, and the ground, so that if the conductors C and Z^1 were of equal conductivity it would make no difference which branch were closed, the total length of C and Z, traversed by the current being the same in each case. On this point it may be said that in either construction shown in the above diagrams, sufficient battery would have to be used to traverse the entire line, and of course the nearer branches in figure 1 would form circuits of less resistance than the more remote ones, but the patentee provided for this by stating that their resistance could and should be adjusted so as to be equal or as nearly equal as possible. Of course this might be done in a wholly metallic circuit by making the portion of the circuit, represented by the dotted line Z^2 of figure 2, a wire forming a continuation of the wire Z^1 connected with the opposite pole of the battery, from that connected with the wire C; but any electrician would see at a glance that this would require three wires and would have no advantage over the method of introducing resistance into the branches nearer the battery, equal to that of the main-lines C and Z beyond the said branches; and that really nothing is gained by using the grounded circuit of figure 2 except what is in any case gained (or it may be lost) by using a ground return instead of a wholly metallic circuit. The Court however decided to the contrary that there was sufficient difference between the circuits employed in figures 1 and 2 to bring the latter out of the scope of the patent granted on the former even if in all other particulars the apparatus were the same. It would follow logically that if the patentee had been so unfortunate as to state that he preferred to use a gravity battery and did not mention any other kind of a battery, and defendant had used for instance a Grove or Leclanché battery, that would also have been sufficient to avoid the patent; and applying the principle that defendant's circuit-closer was a new one not precisely the same as any in existence at the time of the granting of the patent, and consequently not a known equivalent nor an infringement of the same, any inventor may, by devising a new finger-key, avail himself of all the various patents on multiplex telegraphy which have happened to show or mention the ordinary finger-key as governing their operation; or by slightly changing the ingredients of a carbon for an electric lamp, he may avail himself of all the patented inventions on electric lamp regulators which have happened to show or mention the ordinary carbons as used for producing the light.

It is probable that the Supreme Court did not get any understanding at all of the electrical relations of the different devices; and because a pair of rails spiked upon sleepers and a railroad train running or standing upon them appear to be very different mechanically from two small springs pressed together to complete an electric circuit, they came to the conclusion that one was not the mechanical equivalent of the other, although it is probable that the average electrician would fail to discover or even think of any difference at all existing between the two devices, electrically considered. It is to be hoped that the Supreme Court will come to appreciate the difference between mechanical and electrical relations in treating patents relating to electrical inventions, as otherwise such patents will be wholly and absolutely worthless; they are nearly all for new combinations of old elements, and the elements employed in electrical apparatus are exceedingly few; electro-magnets, conductors, insulators, and devices for breaking and closing circuits covering nearly the whole ground. But the different combinations and the variety of results produced from these simple devices is almost unlimited, and the forms which these simple devices assume in their different relations is also practically unlimited, so that if, as indicated by the above decision, an inventor were limited to the precise form of each element which he happened to show for the purpose of illustrating his invention in his patent, the difficulty would be not to avoid infringing the patent but to infringe it.

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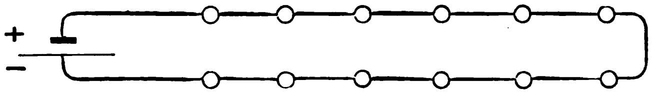
THE DISTRIBUTION OF ELECTRICITY.[1]

In the last lecture we were engaged in preparing the way, as it were, for considering in detail the different schemes which have been proposed for laying the mains from a central station; and the laws which we established in that lecture are applicable not only to a large central station, but even to private installations. I pointed out that there were three different reasons why we cannot seek for economy by diminishing the size of our mains very much: the first is that it is an actual waste of money in consequence of the energy which must be used up to heat those mains; in the second place, when we diminish the size of our mains the heating being increased may cause serious inconvenience in several different ways; and, in the third place, when we have thin conductors, the fall of potential as you go away from the source of electricity is very much increased. I dealt pretty fully with the first two points, the waste of energy in the conductors—a consideration of which leads us to the consideration of the economical size of conductors to use—and, secondly, the heating of conductors. Now let me insist once more on what I spoke of with regard to the economical size of conductors. We must in all our plans for laying mains determine the economical size of conductors by Sir Wm. Thomson's law, and nothing must allow us to deviate from that size of conductor. When we have really accepted this fact we have done a great deal. Very few large stations have been designed on this correct principle. I may mention, for instance, that in the central station in New York there is, as Dr. Fleming informs us, 52 per cent. h. p. wasted between the cylinders of the steam engine and the lamps. Some people have been tempted to depart from the law of the economical size in order to get over the difficulties of the fall of potential, but, as I said last night, these difficulties in regard to the fall of potential must be met as engineering difficulties which can be got over, and we shall see in the course of these lectures that they can be.

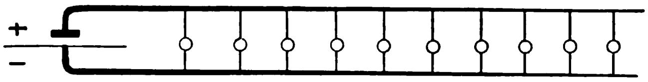
DIFFERENT SYSTEMS OF DISTRIBUTION.

Now we will come to the question of the different systems of distributing our lights. There are several systems which merely depend upon the way of laying the mains; there are other systems which depend upon the introduction of auxiliary appliances. Those which depend upon the way of laying the mains are indicated diagrammatically on the table before you here.



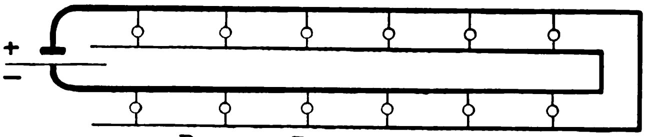
Lamps in Series.

First comes the simplest form, the series, in which all the lamps follow one another in series on a single conductor. Next we have examples of multiple arc systems; in the first one, which I call the parallel line, two conductors diverge from the dynamo, and the lamps are put



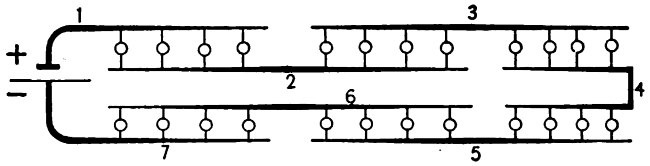
The Parallel Line.

on across the lines. In another kind of multiple arc system, which I call the reversed parallel line, there are two conductors going the whole way round, one end of one of the conductors connected with the positive pole of the



Reversed Parallel Line.

dynamo, and the other end of the other conductor connected with the negative pole of the dynamo, and the lamps are placed across these two conductors. Besides these two systems of multiple arc arrangement there are several others which I shall treat of presently. Passing from these multiple arc arrangements we come to an arrangement which may be called the multiple series, where we have a number of conductors—numbered 1, 2, 3, 4, etc.—the first of which is connected with the positive



Multiple Series.

pole of the dynamo and the last of which is connected with the negative pole of the dynamo, and the lamps are placed, some between 1 and 2, some between 2 and 3, and so on.

The oldest arrangement which was proposed for establishing extensive systems of electric lighting was on the series arrangement; in fact in reading over the evidence given before the House of Commons Committee in 1879 you will find that the series arrangement is the only one spoken of. In using it for incandescent lamps of course the trouble is that there is such a limit to the number of lamps that can be used; that number is limited by the potential, the pressure which we are able to use in our mains. Up to the present time the highest pressure which has been used, that I know of, for any length of time on satisfactory and commercial principles is 5,000 volts. Well, but if we have our lamps of 100 volts each, then 5,000 only gives us 50 lamps; we should only be able to put on 50 lamps to a series. That is a serious drawback. Another drawback is that if one of these lamps goes out the whole will go out, so that it would be necessary in such a system to have an automatic arrangement so that when one lamp goes out it shall shunt that lamp. It is clear, then, that if we want to increase the number of lamps in our series, it will be necessary to use very low potential lamps, while in the multiple arc system it is desirable to have them of as high potential as possible. In series it is best to have a low potential; but this has a serious objection. If we shorten the length of the filament, or if we thicken the filament so as to diminish the resistance we make the cooling effect of the terminals very great indeed. This is very evident in an incandescent lamp that has a very thick filament, such as the Bernstein and the Lodyguine lamps. I think we may safely pass over the question of putting incandescent lamps in series. Arc lamps put in series are eminently successful, and the arrangements adopted in America for keeping the current perfectly constant are such as to shut off any number of lamps, and keep the others working well. I see around me several gentlemen of the British expedition to America last year, and I think every one must have admired the working of the central arc lighting. When we were in Philadelphia—I speak of it because I know it best—whether we were in the dynamo room, where we saw numbers of dynamos at work, or whether we were walking through the streets admiring the graceful festoons of overhead wires and the elegant steel poles on which they were suspended; and feeling the benefit of the graceful wires and powerful dynamos to thousands of our fellow creatures, we could not help feeling admiration for these central stations.

THE MULTIPLE ARC SYSTEM.

I now come to one of the most important systems of distribution, the multiple arc system. It is the most important for this reason, that it has received the greatest amount of attention in the past. I do not say that it gives the greatest prospect of success in the future. When we

1. Cantor lecture delivered by Professor George Forbes at the Society of Arts, London, February 9th, 1885.

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come to speak about the multiple arc system, first of all I wish to direct your attention to the necessity for having as high potential lamps as we can. I am informed by Mr. Swan that if there were a demand for it, there would be no difficulty in procuring a 20-c. p. lamp, of as long a life as those which are made at present, supplied with a pressure of 400 volts. With this authority, I am simply surprised that the thing has not taken a more practical shape. It is a most important thing, as you will easily see when you think that a 20-candle lamp with 400 volts, of equal economy, equal life, with the present lamps, means that the number of lamps which a good conductor would give would be enormously increased. Let us first take the simplest case there is of distribution by the multiple arc system, that is a street with conductors going along a single street, as shown in the second diagram; and we should also consider the case of this reversed parallel line as I have called it. Now you notice I have made these conductors tapering, because, theoretically they ought to be tapering, and practically they must be as nearly tapering as they can be, the reason being that at every point the section of the conductor must depend on the current it is to carry. Now the first thing that strikes us in this system is the very serious obstacle, the falling off of potential. I have assumed, for the purpose of illustration in these lectures, a certain size of conductor, 1½ square inches to every 1,000 ampères. That is not in the least the size that must necessarily be adopted, that must depend on local circumstances; but we must have a certain size to continue, and we will take that. When a conductor of that size is carrying that current, the fall of potential is constant whatever the thickness of the conductor may be, because the fall of the potential is not only proportional to the resistance of the conductor, but also to the current which it is carrying. Of course when the number of lights is diminished, the current will be less and the fall of potential less.

It has been proposed to supply all parts of a district with lamps of the same pressure, and to make up for the increased pressure of the conductors near the engine-house by inserting resistances into the lamps, a high resistance in the first and less as you go along, until there is no resistance at the most distant lamp. This is quite intolerable; it is a most objectionable thing to have to introduce resistances, which are simply using up energy. It is also proposed to use adjustable resistances, so that when fewer lamps are on there shall be not so much resistance, and that these should adjust themselves automatically; but any introduction of resistances like that is very much to be deprecated.

Now what is the greatest distance on such a multiple arc system which we can work with econcmy? That depends upon the variation of potential which we allow. In the Edison lamps of 100 volts, I find that the fall of c. p. at or near the state of normal incandescence is about one c. p. for every volt. I think it would be admitted that a variation of 4 per cent. is about all that we can allow in the pressure. Remember that in this I am obliged to consider the engine as perfectly governed, that is that the electromotive force in the engine-house is perfectly under control. We will allow 2 per cent. up and down, 4 per cent. altogether. Let me show you how it will be necessary to arrange the lamps. Here is a length of conductor separating two lamps; the pressure required for the lamps is 100 volts. I raise one to 102, or a pressure two above its normal, and lower the other to 98, two below. We are able, by giving one station a lower potential lamp, and the other a higher potential lamp to make a greater variation without allowing either of them to go more than two per cent. above or below its normal character. Let the near lamps be of 102 volts and the distant ones 98 volts. When all the lights are on, let one be raised to 104 and the other lowered to 96; when they are all off, let the one be lowered to 100 and the other brought to 100 too. There is never more than 2 per cent. above or below, yet we have a range of 8 volts allowed for the drop in the conductor when all the lamps are on, This is simply to show you that we can by stretching a point work at 8 volts instead of 4. I am, however, against supplying a district by lamps of a different character; therefore I prefer to speak of 4 volts as the permissible fall in potential between the nearest and farthest lamp. Assuming that there is in 100 yards a fall of potential of 3·22 volts, which is the case with the size of conductor I have chosen, there is a fall of potential of 4 volts in 124 yards; therefore, on this assumption, if we supply a district with lamps of uniform pressure, the greatest distance which a lamp can be from a central station on economical conditions is 124 yards. This is a very serious thing, and shows how very limited is this parallel line system.

It has been proposed to get over the difficulty of the fall of potential by using the reversed parallel line. In this case, since one end of one conductor is connected with the positive terminal, and the other end of the other conductor connected with the negative terminal, it looks as if the potential would be constant at every point, and so it would be if the wires were properly drawn. You see I have made them tapering, and so they should be; but on the assumption that they are perfectly uniform it has been shown, first I believe by Prof. Ayrton, that the potential is not constant at different parts if there is a greater consumption of light at one part than at another. Mr. Kapp has also shown that even in the case of a uniform distribution of lamps along the whole circuit, if the conductors are of uniform thickness, the potential is not equal at every part of the line, but is greatest at the two ends; but you will easily see that if the resistance of the conductor at every point is inversely proportional to the current which is passing through it, then the potential at every part would be the same if we had the size of conductor at every point proportional to the current it is carrying. The size of copper which is to be used is exactly the same as if we had a single wire for every lamp, an independent wire going for every lamp in the whole circuit; there is exactly an equivalent mass of copper in every part. The tapering arrangement is also analogous; it is equivalent to forming a circuit for every lamp. And you will find in every system of distribution by multiple arc a mass of copper equal to a separate wire for every lamp, this being the law of the amount of copper required in this system of conductors. What does it mean, this equalization of potentials in this way? It simply means instead of leading the wires up and back again, we interpose an additional amount of copper for the sole reason of putting in resistance, and carry that copper the whole of the way round our circuit. That is worse than in parallel line introducing resistance to equalize potential, because it is introducing resistance equivalent to the length of copper wire, and copper is a very expensive material. Why not make it of some much cheaper material, and have simply an ordinary parallel line with resistance interposed? I think you will agree with me that this short statement is absolutely condemnatory of the reversed parallel line. However, that system bears an analogy to the multiple series system, and for that reason the time spent in considering its conditions has not been wasted, because when we come to the multiple series system we shall understand better how the sizes of conductors should be proportioned.

ARRANGEMENT FOR A LARGE DISTRICT.

I now come to the most important part of the arrangement of multiple arc systems, that is, the arrangement for lighting a large district. In the course of these lectures I have a good many special cases sometimes to take which are not applicable to general cases likely to come before the engineer; for example, the size of conductors, the permissible fall of potential, and so forth. Well, in taking the question of lighting a district, since it is impossible to deal

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with every special district, I have taken a single example. This diagram, figure 1, is a plan of the city of Chicago, and, indeed, of several others in America, of which the names are utterly unimportant. The district is simply made up of rectangular blocks of houses, and I have taken this as an illustrative case to show how the mains would have to be laid. I shall show you that the mains would be laid on three separate systems. To the first system I give the name of tree mains, because it consists of a massive trunk starting from a central station, dividing off into branches, and separating again into twigs and leaflets, and the leaves may be supposed to represent incandescent lamps; then I shall have to speak of a modification of the tree system, which I shall call either the compound or the multiple tree system, in which case a number of different trunks or feeders go out from the central station to different parts, where they branch off; and, finally, I shall have a few words to say on what is called the network system.

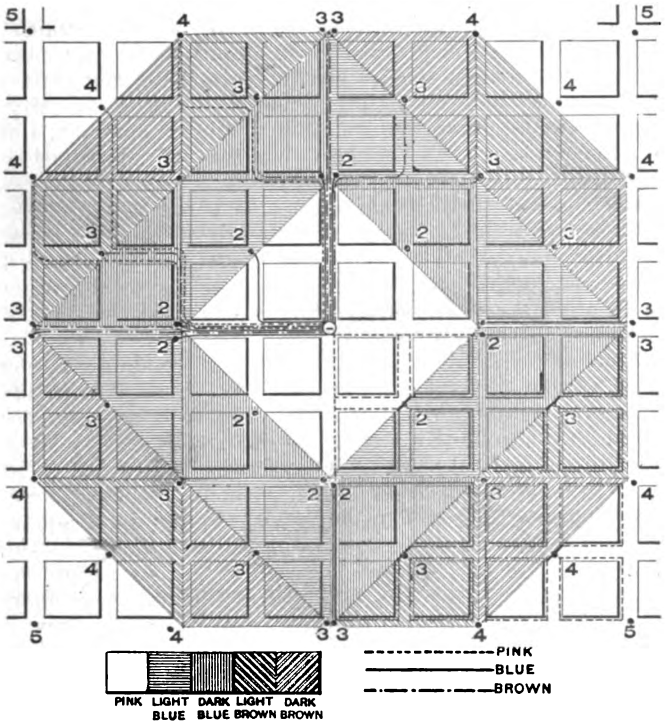

FIGURE 1.

The first thing which has to be done when a district has to be lighted, even before selecting the system of laying mains to be adopted, is to determine the probable consumption of electricity in different parts of the district. This is a very difficult thing to do, of course, and the engineer must bear in mind the fact that the best estimate he can make is probably at fault, and so give a certain latitude in his proportions to allow for probable errors. Another point which it is desirable to get is the probable consumption at different hours of the day and different seasons of the year. These are figures which would probably be fairly uniform in similar districts in different parts of the country, but I have not been able to obtain information on the point. At the same time, I have no doubt that (and especially at gas works) it must be perfectly well known what the average relative consumption is at each of the 24 hours, at the time of the longest day, the shortest day, and at the equinoxes. I should be very glad, indeed, if any gentleman here can furnish me with even approximate data on these points; the information would be very useful. In all the attempts which I know of which have been made to lay down a system of mains, whether it was done on the tree system or the network, there seems to have been a sort of haphazard in the preliminary choice of size of mains and the manner of laying, and then these have been worked up gradually and altered in one way or another. My object is to try to show you that the laws by which these things are to be decided are perfectly definite and clear. The history of research into the matter of distribution is chiefly to be found in the records of the Patent-office. There is nothing more interesting than to read through the various patents which have been taken out, especially by Mr. Edison, in the matter of distribution, and I am glad to take this opportunity of stating how strongly I feel the great forethought which was evinced by Mr. Edison in investigating the matter, so far as he did, at such a very early date in the history of electric lighting. Some of his most valuable and suggestive patents date from the year 1880, when the multiple arc system was in embryo. At the same time I must say that whilst his qualitative suggestions have been so admirable, when he has come to the quantitative determinations and to the actual laying down of the mains, there have been some inexplicable fallings off; so much so, that really in his central station in New York a very haphazard way of laying down the mains has been chosen; and it would have been very well worth while to have calculated the results of the distribution on such a system on paper before laying them down, and I think then most of the difficulties they have now met with would have been foreseen and probably prevented.

That leads me to say another thing about the calculation of mains. When an expensive bridge, like the Forth bridge or the Brooklyn bridge, is to be built, people are not entirely regardless of the amount of metal they are going to put into it. They calculate the weights and strains of different parts with the utmost care, and not simply spend a few hours, but months, and even years, in calculating out these different points. And it is much more important, I think, in laying electric lighting mains, where with 100,000 Edison lamps you have over a ton of copper for every yard run on the multiple arc system, and if you consider the amount of money expended, no amount of care and forethought spent in this direction is wasted time.

First, take the question of tree mains, or a system of mains which covers the whole district, and the trunks of which are all connected together and to the dynamos. This system was treated very well by Mr. Kapp two years ago, but his views were founded, not upon the economical size of mains, but upon the size of mains which would not vary the amount of potential more than the amount permitted by the board of trade. If he had viewed it simply on the economical size of mains he would not have got further than 124 yards, whereas he was able to deal with a much greater amount. Now, let us see what is the size we may have with the money at our disposal. First, we have n, equal to the number of lamps; then r, equal to the greatest distance of any station; then we have e, equal to the electromotive force of the lamp; p, equal to the percentage variation allowed in the pressure supplied to the lamps. The quantity of copper in the mains in any district of a fixed size is evidently proportional to the number of lamps; it also varies with the most distant lamp in two ways—in the first case, the further you go the greater is the length of mains; but as soon as the length of mains is fixed you must increase the mains so as not to let this fall of potential be greater than in a smaller district. For that reason it is necessary, when we increase the distance of the most distant lamp, we must increase the cost of our mains in proportion to r^2. Then the higher the electromotive force of the lamps the smaller the current, and it is inversely proportional to the E. M. F. of the lamps squared. Mr. Kapp found the cost equal to $k \cdot \frac{n r^2}{p e^2}$ where k is a constant quantity r is given in yards and e in volts, and p is the percentage variation of pressure allowed. He found that when the lamps were evenly distributed over the district k was equal to 1·2; therefore, the total cost was equal to

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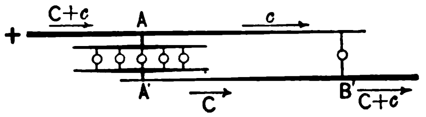
this quantity. Thus, if we were to take 60,000 lamps, n equal to 60,000, r the greatest distance equal to 700 yards, e the E. M. F. of an ordinary Edison lamp of 100 volts, p the variation of pressure taken at 2 per cent. up and down, then the cost of that installation would come out at £882,-000. Now, I would show you how important in this case is the higher E. M. F. of our lamps. If we had 400 volt lamps the cost would be reduced to £55,125. As I have already said, such a system of continuous mains in this way is not consistent with economical principles beyond a distance of 124 yards.

THE MULTIPLE TREE MAIN.

I will now speak to you of a system which I have called the multiple tree main. This system was patented by Edison in 1880, and was adopted by him and others at different times. Mr. Crompton proposed its introduction at Victoria station in 1883, and actually adopted it to some extent in the Law courts. The fall of potential of 4 volts in 124 yards is not necessarily between the station and the lamps, but between the nearest lamp and the furthest lamp which is supplied by that system of mains from the station,



MULTIPLE TREE MAIN.

so that I might have in this way the central station here (indicating), I might have a very long feeding main, and then it might branch off, and I might have one lamp here and other lamps over there (indicating), the distance being 124 yards, and the variation not more than 4 per cent. along the whole length of conductor, provided I keep that point properly adjusted. This was one of the systems provided by Mr. Edison in his patent. Now, the way in which that ought to be carried out is shown in this diagram, figure 1, which gives different colored lines for the different feeder mains which will be required, and I have colored the map in a special way. The pink centre is fed direct from the central station; the blue spaces are fed by distributing boxes marked 2, which are all 124 yards distant from the central station. I have assumed that the distance of two sides of one of these blocks of houses is 124 yards, only to make the thing simpler to describe. The brown district and distributing boxes indicated by the figures 3 are distant along the streets by twice 124 yards, equal to 248 yards, so the pink outside the district marked 4 is three times 124 yards. Then the number of distributing boxes which is necessary is shown here by the number of these marks, 2, 3 or 4, as the case may be. The number is fixed by this consideration, that the distance of the distributing boxes from the most distant lamp it feeds cannot be greater than 124 yards. And here I may draw your attention to an important point which has been almost always neglected in such a system of distribution—that in order to economize copper the distributing box must be nearer the central station than any of the lamps which it feeds. It is almost invariable in schemes for this purpose to place the distributing box in the centre of the district which it feeds. As to the relative size of conductors in different parts of the district, you will see in this arrangement. as in the ordinary tree main system, exactly the same rule holds, that if you will take all the lamps in different parts of your district and lead wires by the shortest route that you can to the central station, then measure the proportional thickness of this bundle of wires in different parts of the route, then you have the most economical proportions of the conductors in different parts which can be given to it, and from the consideration of Thomson's law, you know not only the proportional size of the conductors, but the actual size in every part of the district. Here we have added a most important condition to our actual knowledge: in order to have economical mains we cannot have a lamp further distant from its distributing box than 124 yards, and that distributing box must be nearer to the central station than any of the lamps which it feeds. Thus, if the multiple arc system is to be adopted, this arrangement must be used if we are to comply with the conditions of economy, whatever the difficulties may be of arranging the potentials of the different parts. And here I may point out that it may be necessary to get the potentials of those distributing boxes at fixed amounts. This may be done either by inserting resistances into the trunks and into the feeders which go out from the central station (this is the plan which Edison adopts), or it may be done by using a separate dynamo for every distributing box, or by diminishing the E. M. F. by diminishing the resistance, by varying magnetism of the field magnets; or, as Messrs. Willans & Crompton have been doing, you may govern your engine by an electric governor, which is regulated by the potential of these distributing boxes, so as to keep that potential constant; or you may proceed in other ways: you may have large dynamos to give you 100 volts in all your mains; then you may put in smaller dynamos in large quantity, capable of increasing the E. M. F. by a similar amount, and thus may supply the different centres of distribution. These are points to which I should like to devote a very long time, for a great deal can be said about them; but it will be impossible for me to get through the simple matter of laying mains if I go into the question. Therefore, I must omit further reference to it, as well as to the other important matters connected with the general scheme of distribution.

Now, as to the cost of this system of conductors: you will find that the cost is not nearly so great as with the tree main system. I will give you the data required for calculating out the cost. What is the cost of the feeder to the first nearest distributing box, that is, 124 yards? That is the same as the most distant lamps in any square. Therefore, that portion of a feeder which lights up a square requires twice as much copper as the copper that is in the square. Some of the supply wires of the square go the whole length of 124 yards, but some of them are very short indeed, and the average length of wire in that square is half the length of the feeder main, so that up to the first distributing box the feeder main has twice as much copper as the district which it feeds; therefore, the whole length of the feeder to No. 3 feeding box has four times as much copper as the spaces which it feeds. These are the principles on which you must calculate the expense. You will then find that in the inner district, the cost being L, equals the cost of conductors for one square; then next the central square consists of eight squares, and the cost is eight L, and that gives us L pounds per square of houses. In the second district you will find on calculating it out that it is 2·5 L per square; in the third district it is 3·8 L; in the fourth, 5·2 L. Now compare this with the single system of tree mains, taking Mr. Kapp's data. The first district comes out on an assumption of 200 lamps to the square at £8,000. But look at the second, third and fourth districts. In this table you see the comparative cost with and without feeders:—

	No. of Squares.	Cost.	Cost without feeders.	No. of Lamps.
		£	£	
1 district	8	8,000	8,000	1,600
2 districts	32	90.000	128,000	6,400
3 "	72	280,000	648,000	14,400
4 "	128	672,000	2,048,000	25,600

THE NETWORK SYSTEM.

I will conclude with a very short reference to the network system; only a few remarks are required, because

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the network system is nothing more nor less than that which we have just investigated. There is simply this difference in it, that all the different squares may be connected together, the positive to the positive, and the negative to the negative mains. If all these squares were connected together, the positive mains and the negative mains of the different squares, we should have to choose our conductors exactly of the same size as we have chosen them here, and should have exactly the same conditions. If our conductors were chosen of the proper size for the current flowing, then the current in that case would flow along exactly the same channels as under the system I have been describing; the connections between the squares would have absolutely no effect. That would be the case when we had the maximum number of lamps on. It may be, however, that when the distribution is varying in different parts of the district it may be an advantage to have these different squares connected; and it may also have this effect, that when anything went wrong with a feeder it then would not put a district into total darkness, because that district would be partially lighted with the other feeders. That could be avoided by making each feeder double, because it is very unlikely that two feeders would be injured at the same time. The difficulty in designing the network system up to the present time has been where to put the distributing boxes. Mr. Edison—and possibly others have followed in his lines—has drawn out plans for central stations without considering where to put the distributing boxes at all. This is putting the question in the wrong order; it should be first where to put the distributing stations, and what the size of the conductor; then our network system builds itself up in proper form and dimensions. I need hardly say, if we are to act upon economical principles, and have a variation of potential of not more than 4 per cent., we must have our distributing boxes exactly the same here as in the independent wire system.

We have then arrived at three very important results: first, we must have a large number of distributing boxes, and these distributing boxes must be nearer to the station than any of the lamps fed by them; the distance of the most distant lamp from a distributing box must not be over 124 yards; and the proportionate section of the conductors in different parts of the district must be the same as if we had independent wires coming from every lamp in the district to the central station. Now, when I have used the expression of 124 yards, you must not for a moment consider that as binding; this, as well as the economical size of conductor and the percentage of variation allowable, is dependent upon local circumstances.

THE DANGERS OF MECHANICAL GENERATORS OF ELECTRICITY.[1]

THE more and more general use of powerful electro-magnetic generators has caused several accidents, some of them involving the loss of human life. It is, therefore, desired at present to regulate the employment of electricity, and to determine experimentally the tension and the current which are dangerous in practice. The problem thus set forth is not well put, and is not susceptible of any solution, as the object of the present communication is to show. In the first place, it is not, generally, when the electric current is permanently established that accidents take place, but at the moment of the establishment or of the rupture of the electric circuit. Under these circumstances, the body of the experimentalist re-establishes for a longer or shorter time the continuity of the broken circuit. It is easy to show that, at this moment, the danger incurred depends by no means on the tension and the intensity of the primitive current, as is generally believed, but depends on quite a different factor, which cannot be calculated from a mere knowledge of the tension and the intensity of this primitive current. All physiologists know that the energy of an electric excitement depends much less on the intensity of the current than on the rapidity of the fall of the potential and on the frequency of the shocks. This being established, the following propositions become, so to speak, self-evident :—Proposition I.—A battery and a machine producing in a rectilineal circuit two currents having the same current and the same tension do not present the same dangers. In fact, if we break the circuit in any point whatever, holding in each hand an end of the uninsulated wire, we find that the battery gives scarcely a shock, whilst the machine produces a much more considerable excitement of the nervous and muscular systems—an excitement which, in certain cases, may become instantaneously fatal. The reason of this difference is that the battery in a rectilineal circuit does not give an extra current, whilst the machine, by the mere fact of its construction, gives one, the power of which varies with the length and the manner of coiling of its circuit, as well as with the quantity of iron which forms its framework. The danger, therefore, resides simply in the power of the extra current resulting from the self-induction of the generator. From these very simple considerations, the results of experience, we deduce the following propositions. Proposition II.—Two machines yielding currents of the same intensity and the same tension in a similar circuit may be unequally dangerous, since their coefficients of self-induction, and consequently their extra currents, may be very different. Proposition III.—A current not dangerous in one circuit may be dangerous in another. It is merely necessary to give the circuit a self-induction by any means whatever—*e. g.*, by the interposition of an electro-magnet. I have verified experimentally these theoretical deductions by operating upon Guinea pigs with a Gramme machine (laboratory model) and with accumulators. The tension of the currents employed varied only from 2 to 20 volts, and the current from 1 to 30 ampères. Notwithstanding the feebleness of the currents employed, the Guinea pigs were nevertheless killed. We see, therefore, that, if we wish to suppress all danger in the use of electricity, we arrive at the absurd conclusion that electricity itself must be suppressed. I have sought for a remedy for this state of things. This is the method which has proved efficacious in all cases, and which constitutes a general procedure for the suppression of extra currents. To avoid all danger, what, in short, must be done? Simply prevent the extra current from traversing the body of the experimentalist. We know that the tension of the extra current is infinitely greater than that of the primitive current from which it takes its rise. This being admitted, I place in derivation at the extremities of the electric generator a series of voltameters, with lead plates and acidulated water, in such a number that their electromotive force of polarization may be superior to the maximum electromotive force of the machine. This derivation is absolutely impassable by the direct current, while the extra current traverses it readily. At the moment when the circuit is broken the extra current passes through the voltameters, and the human body is absolutely secure. This is a general and very simple method for the suppression of extra currents. It admits of numerous applications, some of which I have already carried out, but their explanation cannot be given in this brief notice. I take voltameters with leaden plates because they develop practically the greatest electromotive force, and I vary the arrangement according to circumstances. We see that the process which I propose consists in the establishment of a derivation, insurmountable for a direct current, and consequently occasioning no waste of current. This derivation exists only for the extra current. It is analogous to a safety valve, which opens automatically at a given pressure.

1. By M. A. D'ARSONVAL, in the *Comptes Rendus*.

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SOLID v. LAMINATED ARMATURES.[1]

BY SELIMO R. BOTTONE.

CONTRADICTORY statements have appeared in several publications devoted to electrical matters as to the relative efficiency of solid and laminated armatures. In manufacture, a laminated armature is certainly more expensive; hence it must present some decided advantage over the solid form to insure its adoption.

In order to decide the point by actual experiment, the writer fitted up a small dynamo (one of those described in his book) with 7 lbs. of No. 16 c.c. copper wire on the fields. Two armatures, each 1½ in. in diameter, 3¾ in. in length, with a channel ⅛ in. wide, and a web ¼ in. in thickness—one, *a*, solid, weighing 13 oz.; the other, *b*, laminated, weighing 11 oz.—were each wound with 16 oz. of No. 20 silk-covered wire, and then soaked in melted paraffine to insure good insulation. These were both mounted on spindles of the same size, fitted with similar commutators, and, in point of fact, rendered as identical as it was possible for them to be, except in the point of lamination.

When the solid armature, *a*, was fitted to the dynamo, worked as a series machine, it was possible, by driving at a speed of about 3,000 revolutions per minute, to light fairly well four five-candle Swan lamps, arranged in parallel arc, having each a resistance of eight ohms. At this speed the electromotive force was about 10 volts at the terminals.

The laminated armature, *b*, was now substituted, and on trial it was found that the five-candle Swan lamps could be kept brilliantly lighted by a speed of 2,000 revolutions per minute. On adding lamps, and increasing the speed, it was found that six, and even seven, fives could be lighted up, and at 3,000 revolutions the effect with six was as good as the solid armature gave with four. The electromotive force of this machine at this speed was found, on careful measurement, to be about 20 volts; and, in point of fact, it was possible to light well three 10-candle Swans in parallel arc each of 20 ohms resistance. With regard to heating, *a* rose from a temperature of 45° F. to 120° after a 20-minutes run; *b*, after running 20 minutes, had only increased 5°.

In order to render the experiments more conclusive, two exactly similar motors were fitted up, alike at all points except in the armatures. The armatures, *a* and *b*, were fitted to these motors, but so as to be interchangeable at will. No material difference was, however, detected in the field-magnets. These two motors were connected up in series, but back to front, so as to get the driving-wheels to run in opposite directions. The two driving-wheels were then joined together by an endless band, and the motors joined to one and the same battery (so that the same current circulated round both at the same time).

The result was that the motor fitted with the laminated, *b*, armature began to revolve, dragging with it armature, *a*, which was thus obliged to rotate in a direction opposite to that in which it was impelled by its own field-magnets.

To what may this superiority be attributed? Probably three causes are at work simultaneously.

1. The sheet-iron from which the laminated armature was made is softer, more free from carbon, and purer than it is possible for cast iron to be; hence more rapid and more perfect magnetization and demagnetization.

2. The lamination, and consequent separation of the portions of the armature, prevents the formation of the Foucault currents; therefore, the iron core does not get heated.

3. The interstices between the laminations, by allowing the passage of air, help to keep the armature cool; and the coolness of the armature favors the conductivity of the wire, and consequently the efficiency of the machine.

1. *English Mechanic.*

ABSTRACTS AND EXTRACTS.

LIGHTHOUSE EXPERIMENTS.

THE long series of experiments made during last summer and autumn at the South Foreland to test the respective merits of oil, gas and electricity for lighthouse illumination, have been brought to a close, and the reports will now be drafted and published. Pending their appearance—which will necessitate some delay, owing to the voluminous character of the observations—we may mention that the evidence is in favor of the electric light on the whole, because of its far-penetrative power. While the rays of oil and gas-lights were lost sight of at a distance of eight miles, the electric light could be seen for 14 miles; and with gas or oil at its maximum power, and visible for 10 miles, the electric light could be seen for 14½ miles. Although the arc is very much reduced in fogs, it still appears to be visible further than gas or oil. By direct testimony of observers, the electric light became visible in dense fogs at a distance of 1,900 to 1,500 feet, whereas gas and oil were only discerned at distances of from 1,500 to 1,250 feet. This is an important point, because it was thought that gas and oil might have the advantage over electricity in dense fogs. There is no doubt that fog does quench the direct rays of the arc light in a remarkable manner; but how much this would diminish its efficacy in a practical sense was not well known hitherto. Probably the white haze surrounding the lamp is detected for a considerable distance, although the arc itself in a fog has lost its brilliance. So long as this haze is seen, mariners will learn to distinguish it as the lighthouse. The heating due to the use of gas was found to be very considerable. With the original 88-jet burners, the temperature rose to 200° F.; but the subsequent use of 108-jet burners brought it to 300° and 350° F These burners gave an illuminating power of 2,400 candles. The electric arc lamps used gave a light of 12,000 candles each. Four of the gas-burners were superposed in a quadriform arrangement, and three arc lights were sometimes used. For the oil lights, the Trinity House six-wick burners were employed, each giving a light of 800 candles. We may add that, although the experimental trials are for the present over, the photometric observatory and testing towers will be allowed to remain for further use and testing purposes. This is a sensible decision, since, whatever the result of the trials at present, they cannot be regarded as conclusive while the subject of illumination is engaging so much attention.—*Engineering* (London).

ELECTRIC LIGHT ENGINES ON SHIPBOARD.

COMPLAINT is made by some that electric light engines on shipboard do not run regularly, and cause a great deal of trouble by this defect. On some lines, or some vessels, the electric light has been abandoned for this cause. On shipboard electric light engines are connected with and exhaust into the condenser, and this has been a source of trouble also from choking the same. To speak more correctly, the condensers would not do the work, for they were only large enough—and none too large—for the main engines. An electric light engine at work, small though it be, consumes in cubic feet a great deal of steam, and throwing this into the condenser of course creates just so much additional work. Moreover, the exhaust is so rapid that it may almost be termed continuous. It is different in its action on the condenser where the surface is already needed for the main engines from the intermittent action of their exhaust. The cause of irregularity is to be found, we think, in exhausting into the condenser. This takes away the compression, upon which electric light engines depend, to a great extent, for their regulation; there is no other reason why engines of this class should not run as well on shipboard as elsewhere.—*Mechanical Engineer.*

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LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

A SUCCESSFUL MOTOR.

[33.]—Under the head of "Questions and Answers," page 147, Vol IV of the ELECTRICIAN AND ELECTRICAL ENGINEER, I saw a communication from L. T. W., stating he had made a motor in accordance with the directions given in the ELECTRICIAN AND ELECTRICAL ENGINEER, and can get no result with four cells of the Eagles battery. By "getting no result" I am led to suppose that the machine will not run with the battery power above mentioned; whereas, if properly constructed, it should certainly do so with even less.

Nearly a year ago I made a motor about the size of that now being described in your columns, from which I think I get excellent results. For example, it will run at the rate of about 500 revolutions per minute with one small cell of Smee's battery, of the size used in medical apparatus (plates 2x3 in.). With one small bichromate cell (zinc plate 1½x3 in.) the armature attains an extremely high speed, and with four such cells it will run an ordinary shuttle sewing machine at the rate of about 400 stitches per minute while sewing three thicknesses of heavy sheeting. With a battery of six larger cells (plates 3x6 in.) I run my lathe for turning metal, and can do work as rapidly as when running by foot power.

There are several points not to be overlooked in constructing an efficient electric motor, of which there is no mention made in any work I have seen on the subject. E. F. COLE.

ARKWRIGHT, N. Y., April 22d, 1885.

MERCURIAL PENDULUM CONTACT.

[34]—A correspondent writes as follows: "I purchased last winter a good clock which has a seconds pendulum, with the intention of using this pendulum with a circuit and sounder to beat seconds in my observatory. I placed in the lower part of the case a piece of vulcanite with two depressions, in which rest two globules of mercury. Wires leading from the globules make the circuit when a light iron fork attached to the pendulum passes through the mercury as the pendulum vibrates back and forth. Now this fork passes through the mercury freely, and does not interfere with the running of the clock; but when the circuit is made it invariably stops the clock within an hour. I have repeatedly tried it, and always with the same result. The clock will run for days or weeks, and will stop every time the current is made to pass through the fork from globule to globule of mercury. The question is, why is there any more resistance to be overcome when the current is flowing than when not?"

[We cannot give a reason for the stoppage of the clock arising from the action of the current as stated. If any of our readers have met with similar experience, and can explain the cause, we shall be pleased to learn the result of their investigations.—EDITOR.]

QUESTIONS AND ANSWERS.

[66.]—**Course of Electrical Engineering.**—F. F., of Hartford, inquires for information as to what college gives instruction in electrical engineering. Ans.—There are now several colleges and technical institutes of good reputation which give such a course of training. Consult our advertising columns.

[67.]—**Castings for a Motor.**—J. S. L. wishes to know where he can get the castings made for the motor described in these columns. Ans.—It will first be necessary to make or obtain the patterns, after which we presume any foundry devoted to small work will make the castings from them. Some of our readers who have made such motors will possibly give the result of their experience.

[68.]—**Small Incandescent Lamps.**—J. H. F. inquires whether an electric lamp can be constructed and run with a battery whose power will be equal to an oil lamp. How many cells would be required; how long would they last, and what would be the cost per light? Ans.—The manufacture of such lamps and batteries to supply them is now a regular line of electrical business. They are made of various sizes. See our advertising columns.

CORRESPONDENCE.

NEW YORK AND VICINITY.

More Overhead Electric Light Wires.—The Ticker Business Unchanged.—Senator Kiernan Proposed for Assistant Treasurer.—Electric Lighting in Brooklyn.—Impecunious Telegraph Companies.—Long Distance Telephony.—A Whirling Cat in Brooklyn.—Stored Electricity for Sale.—The State Press Looking for a Telegraph Line.—Electric Railway Progress.

THE United States Illuminating Co. is quietly erecting its lampposts through Fulton street in order to carry out its contract with the city. There are at present no indications of the conductors being placed underground to supply the current to this extension of the system. With the exception of the Metropolitan Telephone Co., there appears to be little activity displayed in preparing to comply with the requirements of the underground law, possibly owing to the reason that its provisions cannot be understood. At this date, the bill for the appointment of commissioners to enforce the law has not been signed by the Governor. The Arcade Railway bill is in a similar condition.

Since the expiration of the Calahan patent last month, the Commercial Telegram Co. has continued the use of its tickers, with both type-wheels; and although some subscribers have relinquished the service through fear of legal complications, there are no surface indications of the suppression of the business,

Since the announcement that the Hon. John J. Kiernan, of the Second Senatorial district, would not be a candidate for reelection, he has been mentioned as a possible successor to Thomas C. Acton, assistant treasurer in this city, whose term expires December 31st. Mr. Kiernan has long been identified with the interests of Wall street, and has built up a lucrative business in the dissemination of financial news through his ticker system and manifold slips. His office is still located in the old building, 21 Wall street, where he entered business life as a messenger boy some 30 years ago. Having served two terms as state senator, he is in every sense of the word a well-known man, and his appointment to any public trust would be heartily endorsed by the community.

The Brooklyn aldermen have granted the Citizens' Electric Illuminating Co. the right to light certain thoroughfares of the Western district, the lamps to be each of 1,200 candle-power. If the aldermanic resolutions become operative, 152 electric lights, of 1,200 candle-power, 200 feet apart, would be required on Fulton street, from the ferry to Bedford avenue; Myrtle avenue, from Fulton to Bedford avenue; Atlantic avenue, from the ferry to Fifth avenue, and Court street, from Joralemon to Atlantic avenue. The cost of the lights would be $27,740, or $182.50 each per annum. Should the lights be of 2,000 candle-power, 270 feet apart, 108 lamps would be required, costing $27,594, or $255.50 each. The number of gas lamps displaced would be 852, which cost yearly for lighting $17,483.40.

General J. G. Farnsworth has been appointed receiver of the Bankers and Merchants' Telegraph Co., which is still struggling along. A report has been current that it would be brought into the fold with the Postal Telegraph and Cable Co., which is again to be reorganized. It appears to be a serious undertaking to maintain a competing system under the rates which now prevail.

At a meeting of the Polytechnic Association at Cooper Union, May 21, Mr. A. M. A. Beale delivered a lecture on long-distance telephony, giving a description of the experiments in that direction made between New York and Chicago last winter. He stated that Mr. Gillett, the inventor of the instrument in question, was now in England, and that he proposed to undertake a series of experiments over the cables of the Commercial company during the coming summer. Mr. Beale is now engaged in preparing the instruments for this trial. It will be of interest to those who are anxious to invest in a project of this kind to know that one of the oldest, and perhaps the most thoroughly scientific American electrician, has made a calculation as to the capacity of a conductor required for successful telephoning across the Atlantic. He states that it would be necessary that the copper core of the cable should be 17 feet in diameter, with an outside gutta-percha insulation 5½ feet in thickness, making a total diameter of say *twenty-eight* feet.

A remarkable cat story comes from an electric lighting station in Brooklyn. The engine furnishing the power has a large fly-wheel running in a pit. Recently the cat of the establishment was calmly reposing on the inside rim of the wheel in the pit, when the engine was started up for the night run, and was soon making 20 revolutions per minute. As the cat could not be rescued without stopping the engine, and consequently throwing the district into darkness, the bewildered animal was compelled to continue in its orbit for seven weary hours, when steam was shut off at the usual time for extinguishing the lights. The cat dropped from the wheel in an exhausted condition as the speed slackened, but soon revived, with no indications of injury from its curious experience, after its excursion of about 300 miles.

The time has apparently arrived when stored electricity may be purchased as required; but intending consumers should state for what purpose the current is to be used, and in what quantities,

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when, as the advertisement in the daily press announces, "estimates will be sent." The public has, however, been educated up to a point where they will doubtless hesitate before ordering a very large supply of "bottled electricity."

A very important meeting of the State Associated Press was held in this city on the 20th. Resolutions were adopted directing the executive committee to lease a wire from the Baltimore and Ohio Telegraph Co. if the Western Union insisted on charging an exorbitant price for the same; and the committee was also instructed to report details of a proposition to build a telegraph line through the state for the association and for commercial business.

Electric railway matters are quiet, as it is now generally known that the work of preparation is actually going on. In the course of another month it is probable that an actual trial will be made. The generating station for the Second avenue line will be in Twenty-fifth street, where a suspended sugar refinery has been rented, having a 2,000 h. p. Corliss engine.

NEW YORK, May 22, 1885.

CHICAGO.

Legal Complications Arising from Underground Privileges.—The Tribulations of the Bucket-Shops.—Opening of the New Board of Trade Building.—Burning of a Cable House.—A Coroner's Jury Enlightened by an Electrical Expert.—The Western Union Company Decides to Pay for Overtime.—Indiana Telephone Construction Suspended.—A Monster Underground Cable.—New Incandescent Systems.

UNDERGROUND matters are progressing in Chicago in more ways than one. While the Baltimore and Ohio, the Western Union and the Chicago Telephone companies were busy drawing their wires under the surface, the Chicago Sectional Electric Underground Co. drew the Postal Telegraph and Cable Co., the Bankers and Merchants', Richard S. Newcombe and James G. Smith, into the U. S. Circuit Court, to compel the defendants to fulfil their agreement. The complainants, organized in 1882, were authorized by an ordinance of the City Council, to lay pipes and subterranean wires throughout the city. A lease was made to Elisha Gray to use the lower portion of a conduit from 39th street to the office of the Postal company corner of Lasalle and Washington. This lease was subsequently assigned to the Postal Telegraph and Cable Co. An agreement was made by the complainant with the Bankers and Merchants' company, granting an exclusive privilege for nearly a quarter of a century, to construct maintain, repair and operate in the south division of the city, such lines as they might elect, in the underground company's conduits, but these privileges were not to be transferred to other parties, a forfeiture of rights to inure from violation of the provisions of the contract. The Postal company for its right to use one-half the conduit already laid paid $35,000 in its bonds at 60% of their par value; $21,000 in additional was paid for the balance of the same conduit, and $14,000 was to be paid for additional rights.

Last year the Bankers and Merchants' laid a large amount of pipe, and the Postal company claim to own rights in this also, having purchased privileges of the Bankers and Merchants'. The complainant claims that this was contrary to the Bankers and Merchants' agreement, and prevailed upon the receivers of that company to cut the Postal's wires. Then the latter company petitioned for an injunction, and the Bankers and Merchants' company notified the Underground company with the attenuated cognomen to protect them. It was much like the cry of "save me from my friends," for the complainants were already claiming breach of contract against the Bankers and Merchants', and also that there was conspiracy on the part of the two defendants. A temporary injunction was granted, restraining the Bankers and Merchants' from interfering with the Postal. Finally, and to conclude, Parker of the Postal company has been made receiver of the Bankers and Merchants', the Underground people have quieted down, and the suit has been dismissed by mutual consent. Peace reigns in Warsaw.

There is rebellion in the open board of trade, and the bucket-shops are stricken with trade paralysis. In the new board of trade just opened the sound of the telegraph instrument is heard no more. Anything for the outer world is sent by tube, to the operating room, and the bulls, bears, and other wild animals outside the precincts of the royal circus arena, are without quotations. The occupation of the curb-stone and C. N. D. brokers is no longer a thing of racket and a row forever.

The claim of the board for some time has been that it should be permitted to dictate to whom the news it furnished should be given by the Western Union, as a means of protecting its legitimate business, and claims that the telegraph company has been furnishing the markets to bucket-shops and other traders of low degree, who are thus enabled to speculate as well as their betters. On the other hand the bucket-shops claimed the right to receive the markets as provided in contracts with the Western Union company, and loaded the latter down with injunctions to compel the service they claimed. The attorney of the board saw an escape from the dilemma in the moving of the board, and claims that the injunctions could only hold as to the wires from the old board rooms. New wires could not be used for the carrying out of the old contracts, and so, as soon as the new building was moved into, the bucket-shops had no rights to enforce. Meantime the irate open board and the bucket-shops are in a quandary, whether to trade on New York or St. Louis quotations, and in doubt whether, if they do this, they may not get brought up with some other round-turn invention of their common enemy.

The opening of the new board of trade building was a grand affair. Twenty Sperry arc, and nearly a thousand Edison incandescent lamps lit up the gay and festive scene. The floor of the new building is capable of holding comfortably a number of talking gentlemen far in excess of the former one, and of course the increased noise and confusion is in proportion. Any ordinary signal bell is readily drowned in the racket, and as for the secretary's mallet being heard, it is utterly impossible. It might just as well be made of cotton batting and struck on a sofa cushion. To remedy the difficulty, application was made to E. B. Chandler, general western agent of the Gamewell Fire Alarm Telegraph Co., who arranged one of the largest electrical gongs used by fire departments, so that if one is really listening for it when it is time to strike it—which is done by Ed. Whitford, by a key—one *can* hear it. The trading room of the new building has been christened "Amusement Hall."

On Friday, the 9th inst. the cable house at the north end of the Lasalle street tunnel took fire and was fairly gutted, cutting off all the telegraph wires running north from Chicago, all the District wires, and all the Chicago Telephone Co's. wires which crossed the river at that point. But the city, whose wires were placed underground last season, had not a wire injured, as these were well out of the way. Prof. Barrett is in high glee at this new practical proof of the beauty of the "ground hog" system. Had the fire-alarm and police-wires been in the same position as formerly, these too would have been sacrificed, and an accident of that nature with such a gale as was blowing that day might have cost the city millions of dollars. As it was, over half a million was lost in the south division during the afternoon, by a lumber fire, which, if the signal had not reached the central station, would not unlikely doubled or probably quadrupled the loss, or enough to bury in good shape, every wire in the corporation limits.

Willoughby, Hill and Co., have lately changed their Brush plant so as to bring all their lights which formerly adorned the two fronts of their building at the several stories, to posts at the curb-stone line, where they are aggregated in groups of three, triangularly arranged. These are covered with red, white and blue globes. The design is unique, and quite attractive. The wires are brought from the basement of the building to the foot of, and carried through the centre of, the posts.

While experimentally running the dynamo on the 22d of April, Mr. Chas. B. Schultz, an employé of the Western Electric Co., who were doing the work, mounted a 12 foot ladder to adjust a lamp which refused to burn. In some way he managed to get a shock which partially paralyzed him, and he grasped the bottom frame of the lamp, which not being rigidly fixed, swayed with him, and he fell. As soon as it was seen that he was in trouble, and in response to a scream, the engineer ran to the dynamo, and opened the circuit. Schultz fell about that time, and his skull was crushed by striking the pavement. This fact, in the absence of other information, gave the public the idea that the extra current, at the time of opening the switch killed him. Then again, to brace himself on the ladder, he had placed his foot on the diagonal brace of the pole—ergo it was a ground connection, and *that* killed him also. The coroner's jury had a fearful struggle, and adjourned for expert testimony. The city inspector was sent for, who showed that the ground theory was impossible, as the insulation resistance was over 1,000,000 ohms. That the extra current could not have killed him, for both hands had hold of the negative side of the lamp, and of course no current could have gone through him. A lecture on currents, direct and derived, and sundry other things, illustrated with diagrams, and the facts in addenda, that his internal organs were uninjured and that his hands were not even scorched, and that the lights were not extinguished, finally convinced the six reasonable jurors and a verdict was rendered in effect: "that he was rendered partially insensible by a shock, and was killed by the fall." Mr. Baron, who was aiding Schultz, holding the foot of the ladder, undertook to break his fall, but, as Schultz weighed something like 220 pounds, his efforts were futile, and both fell, fortunately without injury to Mr. Baron.

Quite a stir lately arose in the operating-room of the Western Union, on account of the decision cutting off pay for overtime made by the employés. A petition was circulated and signed by the majority of them, and formally presented to sup't Tubbs. There were meaningless talks of striking, but the wounds in the war of two years ago were not forgotten by the veterans, and it was only talk. Finally the company compromised the matter, and agreed to payment for overtime based on the hourly compensation for regular work, and the war ended without bloodshed.

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The action of the chronic dyspeptics in the Indiana Legislature has induced the Central Union Telephone Co. to shut down on all construction until all the state legislators have gone home to their plowing and pettifogging. In the meantime the unjust law, as the company thinks it, will probably be brought to a test in the Supreme Court of the Hoosier state, and either better or worse times for the company will result from the decision. The horny-handed granger is fast learning the ways of the "stand-and-deliver" gentry, and becomes each year more proficient in the "come-and-see-me" policy.

The Western Union company's cable between the office and the new board of trade, is one of, if not the largest underground cables ever successfully placed. The size and general appearance of the snaky monster reminded one of a garden hose. The entire length from the operating room at the corner of Lasalle and Washington streets to the farther terminal at the new building is half a mile, composed of three sections of 2½ tons each, or a total of 7½ tons. It contains 61 conductors of No. 16 B. W. G., each covered with $\frac{3}{32}$ thickness of kerite insulation; 338 feet of this electrical anaconda are consumed in getting round and through the basement of the new building. Mr. E. B. McClees, of Day's kerite establishment, where the cable was made, superintended the drawing in of the cable, and after joining up the three sections, tested it out, and turned it over to the telegraph company a perfect and complete job of cable laying. No portion was injured in the least, but its immense weight was sufficient to unship the bed of a heavy safe wagon, which carried the mechanical gear used in drawing it into the pipe. The wires are arranged in concentric circles, with one marked wire in each of these aggregations. By this means any wire may be selected at will.

Lasalle street is now about as full of pipes, wires, conduits and things as a grand piano or the harp of a thousand strings is of wires. In future ages when we have all passed over the river, when present systems have become a thing of the past and wires are no longer needed for communication, according to one of our local poets, the crumbling remnants of these, if they do leave any sign, will be a marvel to the antiquary. He says:

"The streets are filling with grave-yard plants—
To earth the wires must go.
The Fire-Alarm and the blue-box lines,
The District and B. & O.,
The B. & M. and the M. U. T.,
And the Western Union too,
The 'lectrical Sectional Underground
And the Telephone—all must go.
And a thousand years from the present date,
When the diggers delve below,
They'll ask "what the dickens are these fool things
I'd really like to know?"

Two new forms of incandescent lamps are about to claim attention here. The Opperman, manufactured in Chicago, and the Stanley, from Pittsburg. The latter is to be run by a three-wire system, in which the central conductor leads to one pole, the two outer ones to the other. The object is to utilize an arc current for both incandescent and arc lamps. As a safeguard against accident each group of lamps is so placed that an equal number is attached on either side the central wire, thus balancing a differential solenoid through which these wires run to the main wires of the arc circuit. Any change in this balance permits a movement of the solenoid core through excess of current in one of the coils, and this results in rupturing the circuit.

The Opperman lamps are made to order, of any resistance, form or capacity required. The firm is driven with orders, and rumor has it that a goodly number of these will make their presence known here in the near future, by their light.

Then there is the Bain company, about which little has been said for some time. Under a new organization the company proposes coming once more into the field, this time with a combination system.

The Mather-Perkins people too are moving. The plant in the Grand Opera House, which has only been in place a few months is already too small and is to be enlarged, while other plants under the same company are expected to take form and blossom before the heated term.

Unless some unforeseen misfortune overtakes the electric light interests, Chicago will soon recover from the black eye the convention gave her, and the next time the association meets here, will be as bright as the best, and the wires will all be underground too.

CHICAGO, May 14, 1885.

WASHINGTON.

The Thomson-Houston System Coming.—A "Pump-log" Subterranean Line.—Wires Ordered off the Government Buildings.—Progress of the Telephone Underground Work.—The Washington Telephone Co.—Proposed Consolidation of the Local United States and Brush-Swan Companies.—Telegraph Messengers on Bicycles.—Legal Proceedings Against the Erection of Western Union Poles.

A NEW electric light company has just been launched upon the Washington public, to use the Thomson-Houston arc light. This was originally intended as a private plant by two of the most prominent business houses on Seventh street, Messrs. Saks & Co. and Lansburgh & Bro., who, at the request of their neighbors, took in so many to share the anticipated benefits, that it became expedient to form an incorporated company. The plant will be located on G street, near Seventh, and the wires run wholly underground down Seventh street, and a short distance westward from Seventh street on Pennsylvania avenue. Although a comparatively small beginning, this enterprise may grow to be one of considerable magnitude, under favorable circumstances. Permission has been obtained from the authorities, and the laying of the wires will shortly be commenced.

Our commissioners have adopted rather a novel plan for the underground cable work. The Western Union Telegraph Co. is to foot all the bills, while the work is done under the direction of the commissioners, the latter thereby assuming all responsibility for damages in laying two 100-wire cables from the company's office, corner Fifteenth and F streets, through F and Fourteenth streets and New York avenue to Seventh street, whence they are permitted to erect a new pole line along Seventh street to the boundary. The cables and air line are each a little less than a mile in length. The conduits for the cables are squared cypress timbers, about eight by eight, with a five-inch hole bored through them, from six to eight feet in length, and joined by dowels. These are laid side by side for the two cables in a trench about two feet deep, and covered up. At intervals of 400 feet openings, about 30 inches, are left between the conduits, and these openings are covered with neat cast-iron boxes. An ordinary No. 9 iron wire is run through each 400 feet from one box to another, and when the work is done the cable is to be drawn from the reel at the main office through these several "man-holes" to the eastern terminus. The cables are without metallic covering, and the question of their durability and efficiency remains to be tested by the experiment. The experiment is also to be tried for a short distance westward, as far as Seventeenth street, the unsightly wires on the treasury building, executive mansion and war and navy department buildings having all been peremptorily ordered off by the new officials. Quite a large number of these wires belong to the Chesapeake and Potomac Telephone Co., and they too are burying their wires as rapidly as possible. On this route they will have 350 wires laid, extending as far as Twenty-second street. Their 450 wires to M street will be continued by three 50-wire cables to S street. These cables are carried through alleys to the centre of the square or block, where a high pole serves to distribute them to the rear of the customer's premises, thus ridding some of the principal streets of the unsightly poles which have grown to be a regular nightmare to our fastidious triumvirate, who regard with a jealous eye anything that militates against the beauty of the streets of the national capital. They seem impressed with the idea that theirs is a national trust, and nuisances that might, for the public convenience, be tolerated in other and busier cities, can find no lodgment here. By the arrangements above noted some 300 10, 20 and 50 wire poles, with their immense cross-arms, disappear from the business centre of the city, to say nothing of the end to the horrible disfigurement of the above-named public buildings, which rank next to the capitol in cost and magnificence.

A year or two ago the Washington Telephone Co. was started here as a branch of the Pan Electric Co., using the Rogers' telephone, of which Attorney-General Garland, Senator Harris, Hon. Casey Young, of Tennessee, and Gen. Jos. Johnston are directors. The branch company controls the patent for the District of Columbia, Maryland and Delaware. It has done but little business here, but considerable in Baltimore and other parts of Maryland. It has recently received some financial and business reinforcements.

The United States Electric Light Co. continues its negotiations and investigations as to the enlargement of its plant, but has reached no definite action. One suggestion is the location at Georgetown, where the waste water of the canal can be utilized for motive power. To this comes the objection that a full steam-power outfit will also be required to meet emergencies when the canal is frozen or drawn off, or the supply reduced by drought and low water in the river above. Another suggestion is a consolidation with the Brush-Swan company, which is now under consideration by a joint special committee of the two companies. The latter has an extensive plant near the capitol now idle, which could be readily utilized, and at a small expense be so applied as to double the present capacity of the United States company. This, with the Thomson-Houston lights previously spoken of, would doubtless supply any demand likely to arise in the near future.

Col. Whitney, who controls the delivery of the Western Union messages in Washington, has, in order to expedite the delivery of long-distance messages, trained six or eight of his messengers to be expert bicyclists, and they now mount their "fiery steeds" and fly over the concrete streets with their despatches, almost annihilating space. Not all the streets are yet concreted, but the boys know which are, and by a slight diversion can always secure a smooth route. The only drawback to this mode of delivery is the frequent break-downs of the fragile machines, and the incidental delay and cost for repairs.

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The feeling of hostility to overhead wires which has been so sedulously cultivated by the authorities and the press of this city, is now reacting to the annoyance of the former. The citizens on the route of the proposed new Western Union air line, on Seventh street, from New York avenue, where it takes up the cables, to boundary, finding remonstrance and memorials fruitless, yesterday filed a bill in equity against the company and the commissioners to stop the erection of poles and wires on that street. Judge Hagner set the matter down for a hearing June 3d, and ordered the defendants to show cause why an injunction should not issue.

WASHINGTON, May 20, 1885.

PHILADELPHIA.

The Pennsylvania Legislature Still Working at the Underground Bills.—More Permits Asked for in Philadelphia.—More Infringements of the Bell Patent.—The Baltimore and Ohio Company Outgrowing its Quarters—A New Time-Ball.

OUR legislators at Harrisburg are still tinkering away at the "underground" question, and they no doubt keep the different companies, or their lobbyists, in hot water a great portion of the time when this all-absorbing question is under consideration. A bill introduced by Mr. Reyburn has passed a second reading, compelling all telegraph, telephone and electric light companies to place their wires beneath the surface of mother earth within six months after notification to do so.

The Electrical Committee of City Councils yesterday favorably recommended the ordinance granting leave to the Thomson-Houston Electric Light Co. to extend its lines by erecting poles and wires on Girard avenue, from Franklin to Twelfth, and Spring Garden street, from Sixth to Broad. It was agreed to recommend the granting of permission to lay an underground electric light wire from the *Ledger* building, along the south side of Chestnut street, to the new bank building of Drexel & Co., at the corner of Fifth street. The ordinance granting permission to the Kensington Electric Light Co. to erect poles and run wires on Frankford avenue, from Girard to Lehigh avenues, and on Second street, from Master to Fourth, occasioned a brief discussion, in which Chief Walker, of the Electrical department, took occasion to say there was no room for any extra poles or wires on the streets named. The subject was referred.

The Bell Telephone company do not seem to be very slow in proceeding against those persons who are supposed to be infringers of their patents. They have again brought suit in the United States Circuit Court in this city against William C. Harris, Jr., and Edward Anschultz, alleging that in the manufacture of telephones, they had infringed upon patents granted to Alexander Graham Bell and asking the court to enjoin the defendants from making the alleged infringement. The case will be heard upon argument.

I understand from undoubted authority that the Baltimore and Ohio company is negotiating for more roomy quarters, the present main office being entirely inadequate, owing to the large increase in business. They are so cramped at present that they have been compelled to place some of their instruments on the sides of the room.

The Hydrographic office has placed a time-ball upon the roof of the Maritime Exchange building, at No. 131 South Second street. It will be hoisted about five minutes before noon to the top of the staff. At precisely 12 o'clock, mean time, 75th meridian, the ball starts to drop. The dropping apparatus is connected directly over the wires of the Western Union Telegraph Co. with the United States Naval Observatory at Washington, D. C. If for any reason the ball fails to drop, it will not be lowered until after 12.30 P. M.

PHILADELPHIA, May 19, 1885.

SAN FRANCISCO.

Working of the Block Signals.—A Time-Ball for Telegraph Hill.—Wanted, a Pacific Cable.—An Economical Telegraph System Which does not Work.—Hegira of Telegraph Operators from Ogden.—Preparing the Ground for the Opposition.

THE introduction of the block system of signaling was accompanied by two or three collisions and a derailment in the Oakland yard of the Central Pacific R. R. Such results are not unusual upon the introduction of a new improvement of this character, but, now that things are becoming more familiar and the nervousness consequent to beginners at anything has worn off, trains are running regularly and confidently over the network of switches. This climate is particularly adapted to that system. No snow, and very little mud, to interfere with thorough insulation.

We are to have a time-ball on Telegraph Hill in this city, connected by telegraph with the observatory at Mare Island (Vallejo), 30 miles away, which will give us local standard time; this coupled with a "probabilities" bureau of our own, for the Pacific coast, under Lieutenant Craig, demonstrates that we are slowly and steadily forging our way to the important position which this coast should occupy in the commercial world.

What a boon to commerce, and what a source of general satisfaction to the reading people of the world would a cable from the Pacific coast to China be; say along the 40th parallel to the Japanese Islands and Shanghai. In this way we could have pure and unadulterated war news, which must now be taken with considerable allowance after passing through the sieve of a British censorship. This cable was contemplated some eight or nine years ago, and the U. S. Steamer Hassler took soundings, but because it did not promise an abundant return for the money to be expended it was allowed to drop. In a few years when Russia will control the Persian Gulf and the Sea of Oman, she may unite with China in establishing direct cable communication with the Western Hemisphere unless England forestalls her by connecting Victoria, B. C., with Yeddo, Japan. England very seldom unites with other countries in promoting any scheme for the public good unless she is to derive the greatest benefit therefrom.

Mr. Ludwig, a Norwegian, who aspires for fame, has invented a relay which will induce its own current and work 500 mile circuits using but a single cell of gravity battery; he has at least convinced a few monied men in California that he can do so, but he could not convince our chief operator by an actual experiment. Of course he got a current from the cell of battery on a round or metallic circuit to Virginia City but when the wire was grounded at both ends here, the cell at one end and the relay at the other, no current could be induced, hence, I fear he cannot *induce* Mr. Gould to accept his metallic circuit relay, but we thank him for his good intentions and commend his laudable ambition.

Eleven men leave Ogden on the 1st of May, because they are worked 12 and 14 hours per day, and that at 20 per cent. less than under the former manager. The result is the public business is placed at the mercy of the very poorest class of operators, who in fact can neither read copy nor send it decently. This mode of doing business is giving the public an appetite for an opposition when it reaches this coast. The manager at Ogden is a competent, reliable man, but it is evident that he is over-reaching himself in his effort to make a record, and Mr. Dickey ought to know by past experience that poor labor is dearly paid at any salary. Mr. Gamble has as yet kept quiet but I understand the Baltimore and Ohio are pushing on vigorously for El Paso.

SAN FRANCISCO, April 27, 1885.

BOSTON.

Pavements Left in Bad Condition by Burying Wires.—A Legislative Underground Scheme.—A Deluge of Telephonic Investigation.—The Apportionment of American Electric and Illuminating Co's. Stock.—Electric Light Wires set Fire to Foliage.—An Electric Train Signal.—Electricity at the Society of Arts.—Economical Mill Lighting.

THE Boston *Evening Transcript*, a paper which has said more in its columns in favor of putting electric wires underground than any other, and said it too, with as little intelligent comprehension of the subject as could be imagined, recently contained an item which must have slipped in by accident, or in some sane moment. It was to the effect that the granite paving blocks on State street were in a dangerous condition at certain points "the first fruits of putting electrical wires underground," all of the "downtown" streets are paved with granite blocks, and when the *Transcript's* tirades have their full effect perhaps a few more streets will be in a dangerous condition. As horses and pedestrians "don't go that way," it would seem fully as advisable to continue the present *dangerous* condition of things overhead.

Among all the legislative schemes for the regulation of telephone charges, penning up and strangling telephone companies etc., there has appeared only one underground scheme. A Mr. Spaulding has been before the legislature with a desire to secure rights for himself and associates in Massachusetts which electrical companies may avail themselves of, for a consideration. I understand Mr. Spaulding's patents have not yet been issued, and that he claims to have a large number of applications pending there, which cover all the various points necessary in an underground system for electrical wires. "Reference to the next legislature" was the report of the Mercantile committee on laying electric wires underground.

The legislative committees are still struggling over the various telephone bills.

"An act to prevent discrimination by telephone companies," has been reported favorably by the committees on mercantile affairs and on the judiciary, to the legislature.

The examinations of witnesses by the committees have been interesting, but have not developed anything very new or startling. It is expected that reports will be made this week upon all the telephone matters—and rumors prevail that the committee stands 6 to 5 against allowing the increase of capital, 8 to 3 against state supervision of telephone companies, with minority reports.

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By the terms of a circular recently distributed among the stockholders, the stock of the American Electric and Illuminating Co. is made exchangeable in the stock of the American Electric Manufacturing Co., of New York, a new company which succeeds, in a larger field, to the business of the corporation first named. The basis of exchange is par for the preferred stock, $3 per share for the common stock. par being $10 in both cases. The new company has made a definite alliance with the Edison company, as I stated in a previous letter.

The electric light wires at Norwich, Conn., indulged in a little playfulness on the evening of the 8th inst. The wires passing through Franklin square touched the large elm trees; a lively blaze was the consequence. Accidents of this character make householders nervous about wires.

On the 15th inst. the Judkins railway train signal was exhibited on the Boston and Providence railroad, a special train being arranged to show the signal to a large party of railroad men. The experiments were most satisfactory. The device is intended to take the place of the bell rope now in use on passenger trains. The following is a general description of the system: An open circuit battery is located at some convenient place on the locomotive from which runs an insulated wire, permanently attached to each passenger coach, and being coupled between the engine and each coach with the automatic coupler. At convenient points in each coach are push knobs for the purpose of transmitting to the engineer any desired signal—to start, stop or back the train. Leclanché batteries are used; this apparatus has been used on the Maine Central and Eastern railroad for a period of six months. It is now used on a regular Boston and Providence train.

On the 9th of April was held the 331st meeting of the Society of Arts, at the Institute of Technology. Prof. C. R. Cross described and exhibited some new apparatus for studying telephone currents. Mr. Geo. W. Blodgett, then explained Boynton's train indicator, designed to be used at railway stations to indicate the time at which a train will leave, and the station at which it will stop.

Col. Livermore, of the Amoskeag Mills at Manchester, N. H., finds that his electric lighting plant gives him a superior service at a price equivalent to 85 cents per 1,000 feet for gas. Comparing this with even the present reduced prices at $1.30 for street gas in Boston proper, and $1.85 to $2.00 in the suburbs, the price appears to be entirely favorable to electricity. But the amount of light required in a mill is much greater than allowed to obtain in the streets. In the weaving rooms of the Amoskeag mills the arc lamps are so numerous that not one of them casts a shadow; and an average of 7.14 hours of light per carbon are obtained, which is a longer period than usually required in mills. In Boston the lights are employed from 7½ to 13½ hours of the day—as for instance in December 13½ hours, and in June and July 7½ hours. To carry the comparison between the illumination of interiors and streets further, it costs more for the latter as they employ long circuits necessitating increased cost for power.

BOSTON, May 19, 1885.

ELECTRICAL NEWS AND NOTES.

OPINION OF THE SUPREME COURT IN THE ELECTRIC RAILROAD SIGNAL CASE.

DECIDED MARCH 30, 1885.

THE decree of the Circuit Court dismissing a bill in equity for an injunction to restrain infringement of letters patent issued July 1, 1873, to F. L. Pope, for an improvement in circuits for electric railroad signals, is affirmed for the following reasons:

1. The patent is for a new combination of old devices. The object of the combination is the accomplishment of a particular result,—to work electric signals on the block system by means of circuits operated by a single battery instead of many. But the thing patented was the particular means devised by the inventor to accomplish that result, and to constitute in this case identity of invention, and therefore infringement, the result, the elements or their equivalents, and the combination must be the same, so that each element shall perform the same function.

2. In the complainant's patent insulated sections of rails as circuit-closers, constitute an essential element of the combination. The statement in the specification that the patentee does not desire to confine himself to the particular devices described for closing the electric circuit, does not permit him to cover, as an equivalent, other forms of circuit-closer, whether before known, or thereafter invented, which would serve the same purpose in the combination.

3. The complainant's patent being for a new combination of old elements, in which a system of branch circuits of equal resistance constitutes one of the ingredients, the particular method in which the resistance of these circuits is equalized is an essential part of the invention. In the complainant's plan the circuits are normally unequal in resistance, and require to be adjusted to an equality in setting up the apparatus, while in the defendant's plan, the circuits are normally equal and do not require equalizing. This introduces new elements, a new combination and a new result.

Appeal from the Circuit Court of the United States for the District of Connecticut.

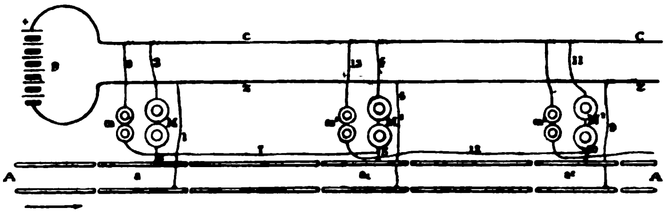
Mr. Chas. E. Perkins and *Mr. Geo. H. Christy* for the appellant.

Mr. S. E. Baldwin for the appellee.

Mr. Justice MATTHEWS delivered the opinion of the Court.

This is a bill in equity for an injunction to restrain the alleged infringements of Letters Patent No. 140,536, for an improvement in circuits for electric railroad signals, issued July 1, 1873, to Frank L. Pope, of whom the appellants, who were claimants below, are assignees. On final hearing the bill was dismissed by a decree now brought here for review by this appeal.

The drawing which accompanies and illustrates the patent is as follows:



The following is the substantial part of the specification, together with the claims:

My invention consists in a peculiar arrangement of electric circuits, in combination with a battery, and with two or more circuit-closers operated by moving trains or otherwise, whereby a series of two or more visual or audible signals situated at intervals along the line of a railroad may be operated by currents of electricity derived from a single battery, thereby obviating the inconvenience and expense of employing, as heretofore, one or more separate batteries situated at or near each signal for the purpose of actuating the same.

In the accompanying drawing, A A represents a portion of the track of a railroad. At intervals of, say, a mile, more or less, sections of the said track, a a^1 a^2, are electrically insulated from the remainder in a manner well understood, and therefore requiring no detailed description. B is a galvanic battery of any suitable construction, and placed in any convenient location near the line of the railroad. Two wires or other conductors, C and Z, are attached to the positive and negative poles, respectively, of the battery, B, and extended to any required distance in a direction parallel or nearly so to the line of the railroad. The conductors, C and Z, may be placed on poles, and should be suitably insulated from each other and from the earth. The conductors, C and Z, are virtually prolongations of the positive and negative poles of the battery, B. Each of the insulated sections of track, a a^1 a^2, &c., is placed at some point at or near which it is desired to erect a signal, and any required number of these may be employed to meet the requirements of any particular case. M, M^1 and M^2 are the electro-magnets which actuate or display the respective signals. The said signals may be of any suitable construction, and should be provided with some suitable means of retaining them in position or action after the circuit through the magnets, M, M^1, or M^2, has been interrupted. The magnets, m, m^1 and m^2, are so arranged as to release, reverse or stop the action of said signals, which have previously been brought into action by the magnets, M, M^1 and M^2.

The operation of the apparatus is as follows: Suppose a train moving along the track, A A, from left to right, in a direction indicated by the arrow. Upon reaching the point, a, the wheels and axles of the train will form an electrical connection between the opposite insulated rails, and a circuit will be formed between the conductor, C, and the conductor, Z, traversing wires 1 and 2, magnet M and wire 3, and the signal attached to M will consequently be displayed. Upon the arrival of the train at a^1 the same operation will be repeated, and another connection formed between C and Z, traversing the wires 4 and 5, magnet M^1 and wire 6, while at the same time a portion of the current will traverse the branch wire 7, magnet m and wire 8. Thus the signal attached to M^1 will be actuated, and simultaneously the action of the magnet m will release or reverse the action of the first-mentioned signal. Upon reaching the point, a_2, the closing of the circuit by the train will in like manner cause the signal attached to M^2 to be displayed, and the signal last displayed by M^1 to be withdrawn. In this manner any required number of such signals may be operated by means of a single battery.

The respective resistances of the several circuits should be so adjusted that they will be as nearly as possible equal to each other, as a much more perfect action of the apparatus will be secured thereby.

On a railroad having a double track two separate series of signals, one series for each track, may be connected with the conductors, C and Z, of a single battery, if required. If preferable, they may be also operated by means of separate batteries and separate conductors.

In cases where it is required to operate a large number of signals extending along the road for a distance of many miles, the two conductors, C and Z, may be extended the entire distance, and a number of batteries attached at convenient intervals—say, for instance, from five to 10 miles apart. The several batteries should all be placed with their positive poles in connection with the wire C, and their negative poles in connection with the wire Z, when they will virtually form one large battery, and the principle of operation will remain the same as that hereinbefore described.

I do not desire to confine myself to the use of any particular form of visual or audible signals, nor to the particular devices herein described for closing the electric circuit at points from which a signal is to be operated. Instead of the circuit being closed automatically by the train itself, it may be closed by a signalman by means of a key or switch, or otherwise.

I claim as my invention—

1. The battery B, in combination with the positive and negative conductors, C and Z, two or more electro-magnets, M M^1 M^2, for actuating, or causing to be actuated, visual or audible signals, and two or more circuit-closers, a a^1 a^2, placed at intervals along the line of a railroad, substantially as and for the purpose specified.

2. The battery B, in combination with the positive and negative conductors, C and Z, two or more electro-magnets, m m^1 m^2, for releasing or reversing visual or audible signals, and two or more circuit-closers, a^1 a^2, placed at intervals along the line of a railroad, substantially as and for the purpose specified.

3. The combination of the battery B. conductors C and Z, circuit-closer a and electro-magnet M, for actuating a visual or audible signal, with the circuit-closer a^1, wires 5, 7 and 8, and electro-magnet m, for reversing, releasing, or stopping said signal, substantially as specified.

Among the several defenses set up in the answer, the two chiefly relied on were: first, that Thomas S. Hall, and not Pope, the patentee, was the first inventor of the improvement claimed; and, second, that the devices used by the defendants were not an infringement of the patent.

The decree below was based on the first of these defenses alone, the Circuit Court finding that Hall was entitled in law to priority of invention; but we have not found it necessary to dis-

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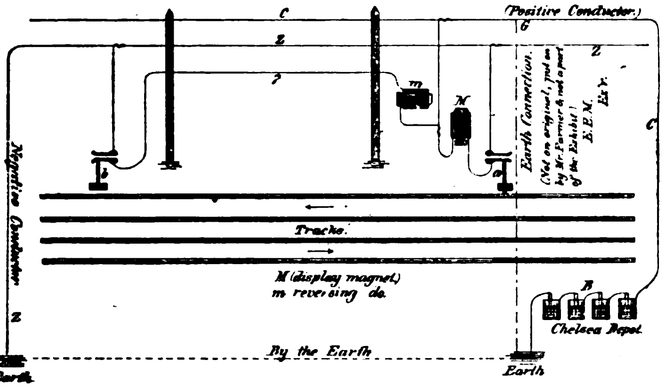
cuss the questions of fact and law embraced in this issue, as we have concluded to dispose of the case upon the ground that the defendants did not, by the devices used by them, infringe the patent of the complainants.

These devices are illustrated by a drawing, of which the following is a copy:



This diagram represents the plan of electric railroad signals placed and put in practical operation by the defendants on the line of the Eastern railroad, near Boston, prior to the bringing of this suit. In comparing it with the drawing annexed to the patent, it is to be remembered that the latter represents a series of double signals in succession on the line of a railroad track divided into blocks, while Exhibit C represents but one pair of such signals in one such block. To make it correspond with the other, as a representation, it should be imagined as being repeated in several successive blocks, constituting portions of one circuit, closed at fixed points by circuit-closers for that purpose.

Mr. Pope, the patentee, drew this diagram, and, as a witness on behalf of the complainants, explains it, in comparison with the plan described in the patent, with a view to establish their identity. He says:

I have made a diagram which exhibits the apparatus which I examined, or so much of it as is material to this case, which I annex, and is marked "Exhibit C." A battery of, perhaps, 100 cells is placed in the station building at Chelsea. One pole of this battery—I think the negative pole—is connected to the earth. A conductor is attached to the other or positive pole of the battery, consisting of an insulated wire extending along parallel with the track upon poles. This wire, which I examined, extended toward Boston, the end remote from Chelsea being disconnected, or, as it is termed, "open." A second conductor, consisting of another similar wire insulated and attached to the same poles, was arranged parallel to the first one. The second wire was open at Chelsea, and connected with the earth at its remote end. The first-mentioned wire I have shown in the diagram, and marked "positive conductor." The second wire is marked "negative conductor." At a short distance from the station a semaphoric signal is placed, consisting of a red disc balanced upon a lever. This was placed in the cupola of a small building at the side of the track. An electro-magnet was arranged, with its armature attached to said lever, so that when brought into action the red disc on the other end of the lever would be moved into a position to render it visible through an opening in the cupola. A latch or detent was placed in a position to fasten the lever after the action of the magnet had ceased, and thus continue the exhibition of the signal. A circuit-closer was placed upon the track at a point near the signal, which consisted of a lever so placed as to be depressed by the wheels of a passing train, which movement caused the circuit to be closed by pressing two springs together. When the circuit was thus closed by a passing train, a connection was formed between the positive and negative conductors, and the electric current in passing from one to the other passed through and operated the magnet by which the signal was displayed. At a point, perhaps, a mile distant, another signal was arranged in precisely the same manner in connection with a second circuit-closer, and the same positive and negative conductors. An additional circuit-closer, placed upon the track in the vicinity of this last-named signal, was arranged to form a connection from the positive to the negative conductor by the way of a third wire running upon the poles back to the signal first mentioned, where it passed through and operated a second magnet, which lifted the latch or detent and allowed the disc to return to a position concealing it from view. I examined two of these signals, and saw many others along the line of the road. I find in this arrangement thus described the combination claimed in the first claim of said patent, consisting of a battery, in combination with positive and negative conductors, two or more electro-magnets for operating visual signals, and two or more circuit-closers placed at intervals along the line of the railroad; also, the combination claimed in the second claim of the patent, consisting of a battery, in combination with positive and negative conductors, two or more electro magnets for reversing visual signals, and two or more circuit-closers placed at intervals along the line of the railway. I also find the combination claimed in the third claim of a battery, positive and negative conductors, a circuit-closer, and electro-magnet for actuating a signal, with a second circuit closer, wires, and a magnet for reversing said signal.

Mr. Moses G. Farmer, an expert witness on behalf of the complainants, makes the same comparison, with the result, according to his opinion, of establishing that the defendants' system is essentially the invention described in the patent. On the other hand, Professor Henry Morton, an expert witness on behalf of the defendants, points out two particulars in which the plan, as practiced by the defendants and shown in Exhibit C, differs from that of the Pope patent so materially that they cannot be considered substantially the same. The first of these is that in the patent, insulated sections of the railroad track, used when covered by a locomotive or cars as a circuit-closer, are made essential to the combinations claimed, while they are dispensed with in the Hall system, other and independent circuit-closers being employed. The second is thus described by Professor Morton in his testimony:

I also find a difference between the plan described in the patent and that shown in Exhibit C in another regard. In the plan of the patent the conductors c and z are connected respectively with the positive and negative poles of the battery, or, as the patent itself states, "are virtually prolongations of the positive and negative poles of the battery."

In the plan shown in Exhibit C, however, the conductor c, or positive conductor only, is connected with the battery, the other conductor, z, or, as it is called, "negative conductor," having no connection with the battery. In consequence of this difference of arrangement in the system of the patent, the positive conductor, c, carries the positive current in one direction away from the battery, and the other or negative conductor, z, brings the positive current in the opposite direction, or back to the battery; and thereby involves the production of circuits of different resistance for each station. In the system represented in Exhibit C, on the other hand, both the conductors, c and z, serve to carry the positive current in the same direction away from the battery, and should, therefore, properly be called "positive conductors." As a result of this arrangement, the current always passes through the same or equal circuits, no matter at which station the connection is made, simply changing from one to the other of these equal parallel wires at the station where the contact is effected. It is for this reason that in this system no equalization of resistance, in the sense involved in the description of the patent, is required.

It is upon these two points that the question of infringement depends. In considering them, it is important to bear in mind that the patent is for a combination merely, in which all the elements were known and open to public use. No one of them is claimed to be the invention of the patentee. He does not claim them himself as separate inventions. It is simply a new combination of old and well-known devices for the accomplishment of a new and useful result that is claimed to be the invention secured by the patent; and the well-settled principles of law, heretofore applied to the construction of patents for combinations merely, must apply and govern in the present case. The object of the patented combination was the accomplishment of a particular result—that is, to work electric signals on what was known as the "block system," by means of circuits operated by a single battery instead of many; but this result or idea is not monopolized by the patent. The thing patented is the particular means devised by the inventor by which that result is attained, leaving it open to any other inventor to accomplish the same result by other means. To constitute identity of invention, and therefore infringement, not only must the result attained be the same, but in case the means used for its attainment is a combination of known elements, the elements combined in both cases must be the same, and combined in the same way, so that each element shall perform the same function; provided, however, that the differences alleged are not merely colorable, according to the rule forbidding the use of known equivalents.

The first question we have to consider upon the issue as to infringement is whether insulated sections of the rails as circuit-closers constitute an essential element in the combinations described in the patent; and that question we are constrained to answer in the affirmative. These insulated sections of track are shown and marked on the drawing which accompanies the specification, and in its descriptive part they are referred to as parts of the arrangement. It says:

At intervals of, say, a mile, more or less, sections of the said track, a a^1 a^2, are electrically insulated from the remainder in a manner well understood, and therefore requiring no detailed description.

And again:

Each of the insulated sections of track, a a^1 a^2, is placed at some point at or near which it is desired to erect a signal, and any required number of these may be employed to meet the requirements of any particular case.

And, in describing the operation of the apparatus, it further says:

Upon reaching the point, a, the wheels and axles of the train will form an electrical connection between the opposite insulated rails [&c.]. Upon reaching the point a^2, the closing of the circuit by the train will in like manner cause the signal attached to M^2 to be displayed, and the signal last displayed by M^1 to be withdrawn.

It is true that the patentee also says in the specification:

I do not desire to confine myself to the use of any particular form of visual or audible signals, nor to the particular devices herein described for closing the electric circuit at points from which a signal is to be operated;

but that he does not thereby indicate any intention of dispensing with insulated sections of the track as a necessary part of the mode of forming and closing the circuit appears from what immediately follows:

Instead of the circuit being closed automatically by the train itself, it may be closed by a signalman by means of a key or switch, or otherwise.

This language evidently implies that the insulated sections of the track are constant factors in the plan, the only alternatives proposed having reference, not to a substitute for them, but merely to another mode of using them in closing the circuit. So in each of the three claims, the circuit-closers, a a^1 a^2, or one or more of them, are expressly named as part of the combination claimed as the invention of the patentee. The use of insulated sections of the railroad-track thus repeatedly appears in every part of the specifications as an unchangeable and characteristic feature of the invention, and there is nothing in the state of the art at that date, as disclosed in the evidence, to show that the patentee would have been justified in applying, or that, if he had applied, an application would have been sanctioned by a grant of a patent for a combination as large and undefined as that now

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claimed by implication and construction, so as to cover every form of a circuit-closer then known or thereafter invented; for that employed by the defendants as part of the Hall system was not only not known and in use at the date of the patent, but was a device invented by Hall himself, or one by Snow, for which the latter obtained a patent dated October 21, 1873. It dispenses altogether with the use of insulated sections of the track, and employs instead a separate instrument placed near the track, and worked by means of a lever connected with the track, so that the wheels of locomotives and cars passing on the track depress the outer end, the lever being raised again and held up after the train has passed by means of a spring, which holds it in place. Upon this point the case seems to fall clearly within the rule declared in *Prouty* v. *Ruggles* (16 Peters, 336); *Silsby* v. *Foote* (14 How., 217); *McCormick* v. *Talcott* (20 How., 402); *Vance* v. *Campbell* (1 Black, 427); *Eames* v. *Godfrey* (1 Wall., 78); *Dunbar* v. *Myers* (94 U. S., 187); *Fuller* v. *Guetzler* (94 U. S., 288); *Imhauser* v. *Buerk* (101 U. S., 647); *Gage* v. *Herring* (107 U. S., 640); *Seymour* v. *Osborne* (11 Wall., 516); *Gould* v. *Reese* (15 Wall., 194); *Gill* v. *Wells* (22 Wall., 1); *McMeenay* v. *Mallory* (111 U. S., 97); *Fay* v. *Cordesman* (109 U. S., 408).

On the second branch of the issue as to infringement, we think the case is quite as clearly for the defendants. In the patent the entire circuit operated by the single battery, and which is closed at intermediate points for the purpose of displaying and concealing the signals, is described as formed by means of two wires or other conductors, C and Z, attached to the positive and negative poles of the battery, extended to any required distance in a direction parallel, or nearly so, to the line of the railroad. These wires may be placed on poles, it is said, and should be suitably insulated from each other and from the earth, and they are declared to be virtually prolongations of the positive and negative poles of the battery. Throughout, the two conductors are designated as metallic, and insulated from the earth, and they are embraced under that description in each of the claims. On the other hand, the defendants' plan does not include a metallic circuit composed of two conductors, as thus described, but uses a circuit composed in part of the earth itself. The material difference in the principle or mode of operation of the two plans, as distinguished in this particular, is indicated by Professor Morton in the extract from his testimony already quoted. It will become more apparent on further explanation.

The object proposed by the plan of the patent is to operate with one battery instead of several along the line of a railroad an electric circuit of considerable length, divisible into a number of subsidiary circuits, for the display of signals at many stations by means of circuit-closers operated automatically by passing trains in definite and predetermined succession. It is obvious that the battery must have sufficient power, being placed at one end of the entire circuit, to operate efficiently at the other extremity. The force necessary for that purpose would be much greater than would be needed for the subsidiary circuits, all of which, it will be observed, are different in length; and this difference of force in the battery might be so great, owing to the required length of the whole circuit, as, when expended upon a shorter intermediate circuit, to destroy its capacity for working the signals by overheating. It becomes, therefore, a matter of importance in some way to equalize the resistance of these varying circuits. The patent itself contemplates this necessity, and undertakes to make provision for it. It is said in the specification that—

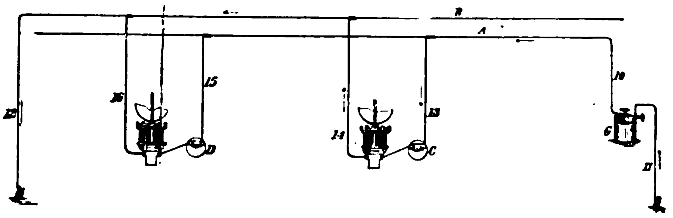
The respective resistances of the several circuits should be so adjusted that they will be as nearly as possible equal to each other, as a much more perfect action of the apparatus will be secured thereby.

The specification does not point out any particular methods for that purpose; but it is stated in the evidence of experts that such means were well known at the time and in common use—such as by varying the dimensions of the wire on the magnets, or the introduction of resistance-coils into the nearer circuits. These devices would be independent of the apparatus described in the patent, and would have to be adjusted to the peculiar situation of each line of signals in practical use. In the Hall system, as used by defendants, no such necessity exists. According to that plan, there is no necessity of equalizing the resistance of the several sub-circuits, for they are all exactly equal by their construction, as the electric fluid, in working the signal at any point, when a sub-circuit has been formed by a circuit-closer, nevertheless traverses the whole extent of the large circuit, and returns by means of the connection formed by the earth to the battery. So that in effect the Hall plan forms its apparatus, counting the connection through the earth, as though it were a continuous wire, as it might be, by means of three lines of conductors, of which two are combined by connecting wires with the magnets which operate the signals at points where the circuit is closed for that purpose, carrying the positive electricity throughout the whole distance to the extreme point of the entire circuit, and then returning it by the third line, which is the connection by means of the earth; and, inasmuch as a wire might be used for this purpose instead of the earth, it would then show three metallic conductors; and Mr. Farmer, the complainants' expert, is quite right in saying, as he does, that the equalization of the resistances in the several sub-circuits, accomplished in the plan of Hall—

is due to the arrangement of the wires wholly, and not at all to the fact that the earth is used as a portion of the conductor.

This arrangement is altogether unlike that of the patent. It introduces into the plan of the defendants new elements, a new combination and a new result. The two wire conductors are not the same, for in the patent one conducts positive electricity, the other returns the current and completes the circuit, while in the other both the metallic conductors carry the current forward while the earth returns it, and in this mode the desideratum is obtained of securing equality of resistance by making all the circuits equal in size.

The device cannot be regarded as a substitute or an equivalent for anything contained in the complainants' patent. It is of itself an independent invention, and as such forms the sole subject of a patent granted to Hall and Snow, July 13, 1875. To explain more satisfactorily the mode of its operation, so as to show that it differs substantially from the arrangement of the complainants, the descriptive parts of the Hall and Snow patent and the attached drawings are here given:



In the drawing the letters A B designate two wires which extend along the line of a railroad track, or, in other words, form the line wires of a telegraph line. The wire A connects by a wire, 10, with one—say, the positive—pole of a galvanic battery, G, and the other pole of this battery connects by a wire, 11, with the ground. The battery, G, is supposed to be situated at one end of the line, and at the opposite end of said line the wire, B, is made to connect by a wire, 12, with the ground. Along the line are distributed a series of keys or circuit-closers, C D, each of which is connected with the line wires, A B, the connection of the circuit-closer, C, being effected by wires 13 and 14, and that of the circuit-closer, D, by wires 15 and 16. If the circuit is closed through the circuit-closer, C, the current passes from the battery through wire 10, line wire A, wire 13, circuit-closer C, wire 14, line wire B, and wire 12 to the ground, and through the ground and wire 11 back to the battery. If the circuit is closed through the circuit-closer D, the current from the battery passes through wires 10, A, 15, circuit closer D, wires 16, B and 12 to the ground, and through the ground and wire 11 back to the battery.

From these two examples it will be seen that whenever the circuit is closed along the line the electric current has to traverse the whole circuit, and consequently the resistance is the same in all cases.

It thus clearly appears that the difference in this particular between the invention claimed by the complainants and the alleged infringement is a difference in the arrangement of the parts and in the principle of the combination, with different elements performing different functions; and that the difference is something more than the mere substitution of a connection by means of the earth for one of the conducting wires. The case is, therefore, clearly distinguishable from that of *The Electric Telegraph Co.* v. *Brett* (10 Com. Bench, 838), cited and relied on by counsel for the appellants as in point, where the substitution of the earth for a wire as a conductor, being the sole difference, was held, under the English patent laws, not to be sufficient to destroy that identity between the two competing devices which constituted in that case the infringement alleged, although the patent itself called only for metallic conductors. Were that the only difference between the two plans under examination in the present case, there might still be question, in view of our own patent laws, whether the patentee has not made a wholly metallic circuit a necessary part of his combination, to be determined by considerations which we have not thought it necessary to bring into view as bearing upon that point, for, as we have seen, the difference on which we ground our conclusion that the defendants are shown not to have infringed the complainants' patent in this particular is not merely that they have used the earth for the return of the current that completes the circuit, instead of a metallic conductor, but that they have arranged their conductors in reference to the battery, the magnets, the rails and the earth, upon such a system and with such relations and connections that in operating their signals by a single battery the circuits are equalized as to resistance, while in that of the plaintiffs the circuits are of unequal size and resistance, requiring for successful practical use the equalization of the resistances thus created by means of independent and additional devices. One plan proceeds upon the idea of unequal circuits to be afterward equalized; the other adopts and embodies the idea of avoiding the necessity of subsequent rectification by an original adjustment of equal resistances. The difference is inherent in the two combinations and is substantial.

On the ground that in the two points mentioned the defendants' system of signaling is shown not to be an infringement of that described in the patent of the appellants, the decree of the Circuit Court dismissing the bill is affirmed.

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THE SAWYER AND MAN PATENT FOR INCANDESCENT LAMPS.

UNITED STATES PATENT OFFICE.

William Edward Sawyer, of New York, and Albon Man, of Brooklyn, N. Y., Assignors to Electro-Dynamic Light Company of New York.

ELECTRIC LIGHT.

Specifications forming part of Letters Patent No. 317,676, dated May 12, 1885. Application filed January 9, 1880.

To all whom it may concern:

Be it known that we, William E. Sawyer, a resident of the city, county and state of New York, and Albon Man, a resident of Brooklyn, in the county of Kings and State aforesaid, both citizens of the United States, jointly have invented certain new and useful improvements in electric lamps, of which improvements the following is a specification.

Our invention, speaking generally, relates to that class of electric lamps employing an incandescent conductor inclosed in a transparent hermetically sealed vessel or chamber, from which oxygen is excluded, and constitutes an improvement upon the apparatus shown in letters patent No. 205,144, granted to us June 18, 1878.

Our invention relates more especially to the incandescing conductor, its substance, its form, and its combination with the other elements composing the lamp. Its object is to secure a cheap and effective apparatus; and our improvement consists, first, of the combination, in a lamp chamber composed wholly of glass, as described in patent No. 205,144, of an incandescing conductor of carbon made from a vegetable fibrous material, in contradistinction to a similar conductor made from mineral or gas carbon, and also in the form of such conductor so made from such vegetable carbon, and combined in the lighting circuit within the exhausted chamber of the lamp.

Fig. 1.

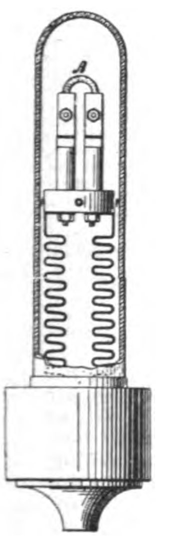

Fig. 2.

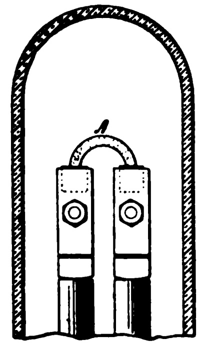

Fig. 3.

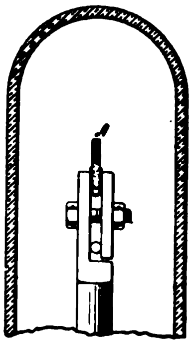

Fig. 4.

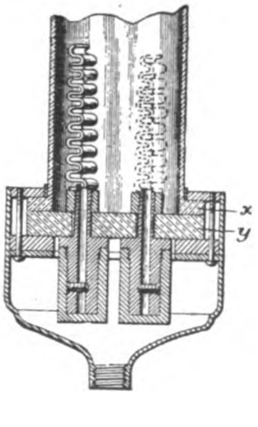

Fig. 5.

The accompanying drawings show all our improvements embodied in an apparatus or lamp substantially like that represented in the patent above referred to, being the form in which we have practically used it; but some of our improvements may be used in connection with other forms of lamps with equally good effect.

Reference being had to said drawings, figure 1 is a top view of the lamp; figure 2, a side elevation thereof; figure 3, a side view in elevation of the burner on an enlarged scale to show its details more clearly, and figure 4 is a similar edge view.

Figure 5 of the drawings shows a vertical section through the bottom of the lamp. In this figure x is a glass flange on the bottom of the lamp chamber; y is a glass disc corresponding in size to the flange, and is ground to the bottom thereof to form an air-tight joint, so that the entire wall of the chamber is formed of glass, the electrodes passing through the glass disc in the manner shown to form the lighting circuit in the chamber, substantially as in said patent No. 205,144. The sealing of the electrodes, where they pass through the glass wall, is done with any suitable cement, or in any of the well-known methods of sealing glass upon metal electrodes previous to the filing of this application.

The electric connections of this lamp are made in the base thereof, substantially the same as in our patent No. 210,809, dated December 10, 1878, and the whole bottom is inclosed in a cup filled with wax or other suitable cement, the same as in that patent, the cement sealing in this lamp being also applied in substantially the same way as in the patent last above mentioned, the invention making the subject matter of this application being improvements upon the lamps described in the patents above referred to, to the extent of the claims making part hereof.

In the practice of our invention we have made use of carbonized paper, and also wood carbon. We have also used such conductors or burners of various shapes, such as pieces with their lower ends secured to their respective supports, and having their upper ends united so as to form an inverted V-shaped burner. We have also used conductors of varying contours, that is, with rectangular bends instead of curvilinear ones; but we prefer the arch shape.

No especial description of making the illuminating carbon conductors, described in this specification and making the subject-matter of this improvement, is thought necessary, as any of the ordinary methods of forming the material to be carbonized to the desired shape and size, and carbonizing it while confined in retorts in powdered carbon, substantially according to the methods in practice before the date of this improvement, may be adopted in the practice thereof by any one skilled in the arts appertaining to the making of carbons for electric lighting or for other use in the arts.

An important practical advantage which is secured by the arch form of incandescing carbon is that it permits the carbon to expand and contract under the varying temperatures to which it is subjected when the electric current is turned on or off without altering the position of its fixed terminals. Thus the necessity for a special mechanical device to compensate for the expansion and contraction which has heretofore been necessary is entirely dispensed with, and thus the lamp is materially simplified in its construction. Another advantage of the arch form is that the shadow cast by such burners is less than that produced by other forms of burners when fitted with the necessary devices to support them.

Another important advantage resulting from our construction of the lamp results from the fact that the wall forming the chamber of the lamp through which the electrodes pass to the interior of the lamp is made wholly of glass, by which all danger of oxidation, leakage or short-circuiting is avoided.

The advantages resulting from the manufacture of the carbon from vegetable fibrous or textile material, instead of mineral or gas carbon, are many. Among them may be mentioned the convenience afforded for cutting and making the conductor in the desired form and size, the purity and equality of the carbon obtained, its susceptibility to tempering, both as to hardness and resistance, and its toughness and durability. We have used such burners in closed or hermetically-sealed transparent chambers, in a vacuum, in nitrogen gas, and in hydrogen gas; but we have obtained the best results in a vacuum, or an attenuated atmosphere of nitrogen gas, the great desideratum being to exclude oxygen or other gases capable of combining with carbon at high temperatures from the incandescing chamber, as is well understood.

The nature of our inventions and the operation of our improved lamp will be readily understood from the foregoing description and the following claims.

We claim as our joint invention:

1. An incandescing conductor for an electric lamp, of carbonized fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth.

2. The combination, substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonized fibrous material, included in and forming part of said circuit, and a transparent hermetically-sealed chamber in which the conductor is enclosed.

3. The incandescing conductor for an electric lamp, formed of carbonized paper, substantially as described.

4. An incandescing electric lamp consisting of the following elements in combination: first, an illuminating chamber made wholly of glass hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven; second, an electric circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described; third, an illuminating conductor in said circuit, and forming part thereof within said chamber, consisting of carbon made from a fibrous or textile material, having the form of an arch or loop, substantially as described, for the purpose specified.

In testimony whereof we have hereunto subscribed our names this 8th day of January, 1880.

William Edward Sawyer,
Albon Man.

Witnesses:
Wm. H. Church,
Wm. D. Baldwin.

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ANNUAL MEETING OF THE AMERICAN BELL TELEPHONE CO.

At the annual meeting of this company held at Boston, March 31st, the old board of officers was re-elected with the exception of Judge Bradley, director, who retires on account of ill health, Mr. Charles E. Perkins being his successor. The annual report of the directors was read, the most important points of which are given herewith.

BOSTON, March 31, 1885.

To the Stockholders:

Telephone business in the year ending Dec. 31, 1884, has shared the dullness which characterized most branches of industry during the same period. Nevertheless, the increase in the number of subscribers and the telephones in use has continued, although at a diminished rate.

The following comparative statement gives the statistics for the year, which are substantially correct, although exact figures in regard to some of the items cannot be insured, as a considerable portion of the properties are not under our direct ownership and control:

EXCHANGES.

	1883.	1884.	1885.	Inc. over 1884.
Exchanges	725	906	764	*142
Branch Offices	345	419	481	62
Miles of wire on poles	....	....	88,441	....
Miles of wire on buildings	....	....	11,886	....
Miles of wire underground	....	....	1,225	....
Total miles of wire	68,571	85,896	101,592	15,696
Total circuits	74,484	97,422	107,268	9,846
Total subscribers	97,728	123,625	134,601	10,976
Total employés	3,716	4,762	5,162	400

EXTRA-TERRITORIAL LINES.

	Jan. 1, 1883.	Jan. 1, 1884.	Jan. 1, 1885.	Inc. in 1884.
Number of lines	247	598	826	228
Miles of pole lines	6,154	29,592	25,766	5,174
Miles of wire	18,658	29,359	35,631	6,274

*Decrease.

Instruments in the hands of licensees under rental: Dec. 20, 1882, 237,728; Dec. 20, 1883, 298,580; Dec. 20, 1884, 325,574; increase during year, 26,994.

The average daily number of exchange connections in the United States is 697,966, or a total number per year of 251,267,760, the subscribers paying, according to the size of the exchange and the character of the service, from 3.1 to 5.7 cents per connection. The average daily number of extra-territorial connections (that is, connections between a resident of one exchange district and a resident of another exchange district) is 7,526, or a total number per year of 2,709,360. Our share of the receipts from extra-territorials and toll business has increased nearly 50 per cent. over the receipts of the previous year. It will be noted that during the year there was a net gain of 10,976 subscribers in the exchanges, with an increase in miles of wire of 15,696. As a rule, all the larger exchanges have a steady growth, and there seems no reason to doubt that this will continue for some time to come. On the other hand, there is a pause in building exchanges in small places, and some 78 of those already started have been for the present given up, while 61 new ones have been established. The establishment of these systems in small towns was probably pushed too rapidly in view of the stagnation in general business which followed. Many of those now abandoned will be restored upon a revival of business, and others can be put into operation under a system which is being worked out for small exchanges without a central office, and which, if as successful as we hope, will carry the telephone into a large number of towns and villages where it is now impossible to place them upon a paying basis. The table shows an apparent decrease of 142 in the number of exchanges reported, but 125 of these have been redistricted as branch offices and are still in operation, while 63 branch offices have become toll stations.

The process of taking the wires from housetops and placing them on pole lines has continued, and now there are in the exchanges 88,481 miles upon poles and only 11,886 miles upon buildings. Great progress has been made in getting the heavy overhead lines into aerial cables in the cities. This is an important step, and one that is materially reducing the unsightliness of the telephone systems, while adding to the safety of the wires and reducing the cost of maintenance. There are now 4,300 miles of wire in 69 miles of aerial cables in use. Some progress has been made in getting wires underground for short distances in the cities, and 1,225 miles of wire underground are now reported. In New York, the legislature, against the recommendation of the Roosevelt committee, to whom the matter was referred, passed an act requiring telephone companies in cities of over 500,000 population—that is, in New York and Brooklyn—to place all wires underground before Nov. 1, 1885. This is wholly impracticable for several reasons. In the first place, no method is known by which entire telephone exchange systems can be worked underground, although for limited distances and in certain localities fairly satisfactory results can be obtained. Even were the methods discovered, part of the wires must be overhead for distribution from central points and for reaching places where subscribers are so few that the cost of going underground would be out of all proportion to the price they could pay. Again, to place even the bulk of the 6,639 miles of wire in the New York and Brooklyn systems underground in one year, would involve the tearing up all at once of most of the streets in those cities, and would not for a moment be permitted. In New York, however, some important underground work will be done this summer, the results of which will possess great interest for our company, and if favorable, we expect to follow them up with extensive improvements in this direction.

* * * * * * *

Nearly all of the licensed companies are in good condition, and many of them continue to pay regular dividends in spite of the general dullness. It has not, however, been a year when new enterprises of any kind could be easily promoted, and, in common with other industries, the telephone companies have found it difficult to sell stock or bonds for their construction purposes. It has been probably as much due to this as to the lessening of the demand for telephone service that our output of instruments has decreased. Most of the companies have met this condition of things by applying their net earnings in part, and in some cases wholly, to their new construction. The result of this conservative policy, although temporarily disappointing to stockholders, has been to materially increase the intrinsic value and earning capacity of the properties, and in view of the importance of an early occupation of the field while numerous infringing claimants were striving to gain a foothold, we have no doubt the policy was the right one. How far it should be continued under the more favorable conditions that now prevail is to be carefully considered by each company.

The amount of net earnings applied to new construction in those of our licensed companies in which we hold stock is stated by our auditor to be $806,633.97, out of a total spent for construction in 1884 of $1,505,907.64.

The absence of revenue to our company from its investment in the New England Telephone and Telegraph Co. is noticeable, and is owing to the fact that we have been obliged to use the net earnings of Boston, which, but for the consolidation of the Boston exchange with several New England companies, would have been a constant source of income to us, in the reconstruction of the exchanges and lines outside of Boston. From this it will be apparent that the charges made against the American Bell Telephone Co. of having gained an advantage over the New England companies by the consolidation, is so far from being true that we have actually lost money by the transaction. The New England company have earned in the year ending Dec. 31, 1884, gross $912,-621.75, and net, $222,441.63, of which $192,098.77 has been spent for construction.

In Canada the Minister of Agriculture has declared the Bell patent void on account of alleged failure to comply with the law requiring manufacture in Canada of patented articles, and with another requiring that such articles shall be offered to the public. The action of the Bell company of Canada in these regards has been taken in accordance with the best legal advice that could be obtained in Canada, and the decision of the minister has occasioned much surprise there. The matter will be carried, if necessary to the Privy Council of England. The infringing company will be at once sued under the other patents owned by the Bell company, and in the meantime the net earnings of the company will have to be used for construction. The company is carefully managed, and its net earnings for the past year have increased to $118,952.-78 on a capital of $1,000,000, and of these earnings $88,951.78 have been spent for construction.

* * * * * * *

The business of the Western Electric Co. has especially felt the effects of the general depression. The gross business for the year ending Dec. 1, 1884, was $1,534,784.04, and the net about $110,000, or 11 per cent. on the capital stock.

The question of how to consolidate its business with advantage is under consideration. Mr. W. S. Smoot, formerly with the Remington Arms Co., has been elected president, and we expect to secure an increase of business with a less expensive system of operation before long. The company has, since October, 1882, put the net earnings into the business, but has just declared a dividend of 1½ per cent—$15,000.

The experimental line between Boston and New York has proved entirely successful. It was built with a metallic circuit of two copper wires (hard drawn No. 12), and was placed upon poles belonging to the several companies occupying the route via Providence. Conversation can readily be carried on in low tones, the speaker's voice being easily recognized. There can no longer be a question of the success of long-distance lines between all points within 200 or 300 miles of each other, and even more, when the demand for such services is of a character to warrant the building of metallic circuit systems. Such systems will be very costly, and our present licensed companies are neither provided with capital nor organized for the purpose of undertaking a work of the proportions which commercial success in this business will involve.

It therefore becomes necessary for one company to take the lead in building lines of connection between the large cities, and

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a beginning will be made this summer between New York and Philadelphia.

As we have already nearly reached the limit of our authorized capital, it is necessary either to obtain authority for an additional amount or to devise means of raising what may be required in some other way than by an increase in our capital stock. The preference for the latter method, however, being general, we have applied to the Massachusetts legislature for authority to increase our capital to $30,000,000, in order that we may be equipped both for the work just described and for the extensive enlargment of our business in any branches that may appear desirable. It should be understood that it is not proposed to issue any part of this stock except for the development of our business.

As soon as definite arrangements can be made for going forward with the work, the directors will place before the shareholders their programme for such enterprises as it is thought best to undertake this spring and summer.

Among the inventions of the year, that of a new transmitter, by Mr. Francis Blake, is prominent, and most excellent results are hoped for in its adaptation to both long and short lines. We expect to test it shortly in actual use in our own business. Mr. Blake has offered it to the company on terms which are thought favorable, provided the tests result satisfactorily.

* * * * * * *

It is hoped that this year will see the end of the most vexatious and expensive part of our litigation, and that the accumulating decisions of our courts that Bell invented the telephone will enable us to prevail with ease against the infringers in all parts of the country, and will deter capital from investing in infringing companies.

* * * * * * *

In view of the statements which have been circulated that the larger part of the stock of the American Bell Telephone Co. represents merely water, it may be well to recall to the stockholders the fact that out of the $9,602,100 of issued capital stock about $5,000,000 has been paid in cash by the stockholders of the National Bell and American Bell telephone companies, $190,000 represents property taken over by the National Bell Telephone Co. at its organization and $105,000 is still in the treasury, and the balance represents patents. And in addition to the $5,200,000 paid in cash or property, net earnings have been used to the amount of $351,000 in increasing the plant of the company. As showing the magnitude of the telephone business it will be interesting to know that the capital stock of the telephone companies in the United States operating under the Bell patents (omitting the American Bell Telephone Co.) was on Jan. 1, 1885, over $53-000,000. The gross earnings were, partly estimated, over $9,500-000 and the net earnings, partly estimated, $3,450,000, showing a gain over the earnings of 1883, although to what extent it is difficult to say, as some of the companies failed to report the increase, and several have not been in business long enough to be able to furnish the comparison.

At this time, when the question of the rates charged to the users of telephones is being discussed, both in legislatures and by the public, it seems proper to call the attention of the stockholders to a few facts in relation to this subject.

The average cost of a connection to a subscriber varies from $3\frac{1}{10}$ to $5\frac{7}{10}$ cents, as has been previously stated. For this sum the telephone company is obliged to keep at the service of the subscriber a wire, which for a large part of the time is idle; to keep an operator ready to receive his calls at all hours; to maintain his telephone and batteries in good condition; to provide for the rapid depreciation of poles, wires, switch-boards and all the apparatus of the central office, and, finally, to provide all the improvements in apparatus which each year develops, for the public very properly insists on receiving the most efficient service that can be given.

As an instance of the rapid depreciation of property, and of the changes likely to occur in electrical inventions, it may be well to say that the telephone system in Boston has been twice re-built, and the new multiple switch-boards for the Boston office had hardly been received, and had not been put in place, when the invention of an improvement in detail gave such promise of excellent results that the boards were shipped back to Chicago to have the new invention added to them.

The sum then charged to the subscriber does not seem large when the cost of the service rendered by the telephone company is considered. Neither does it seem exceptional, when it is seen what the subscriber receives for his payment of three to six cents. He obtains an immediate conversation with any subscriber to his exchange, a conversation which renders needless the employment of messengers, telegraphs, and even the mail, all of which modes of communication are either slower or more costly, and often both more slow and more costly and less satisfactory than that which is given by the telephone. The subscriber also obtains the privilege of communicating, for a small extra charge, with the subscribers of any exchange in towns or cities within a limited distance from his own. And as the number of subscribers in each exchange increases, and as the distance through which telephonic communication is possible become extended, the advantage to the subscriber is also greatly increased.

Finally, we may continue to hope that, as the season opens and the general business outlook becomes brighter, and as the infringing companies are one by one compelled to acknowledge the validity of the Bell patents, the telephone companies will also share in the returning business prosperity.

The treasurer's report was presented in print. A vote was passed, in conformity with the recommendation of the directors, to increase the capital stock from $9,800,000 to $10,000,000.

STATISTICS OF TELEGRAPH LINES OF THE WORLD.

Country.	Year.	Number of Stations.	Length of Line (Kil'm'tr's)	Length of Wire (Kil'm'tr's)
United States	1882	13,528	230,875	728,911
Germany	1882	10,699	74,313	265,058
France (Continent and Corsica)	1882	....	75,091	232,451
Russia	1882	2,968	101,519	229,947
Great Britain and Ireland	1882	5,443	43,632	213,254
British India	1882	....	84,416	98,666
Austria	1882	2,696	36,043	93,993
Italy	1882	1,747	27,788	93,974
Mexico	1883	282	28,122	84,366
Canada	1883	2,550	....	72,419
Indo-European system	1883	1,069	15,831	56,730
Turkey	1883	417	27,497	52,142
Spain	1882	....	21,094	46,223
Belgium	1882	855	6,147	29,122
Chili	1882	127	8,943	26,700
New South Wales	1882	....	....	25,589
Argentine Republic	1882	307	13,543	23,288
Japan	1882	112	7,808	21,031
Sweden	1882	184	8,373	20,433
Queensland	1883	....	....	17,851
Norway	1883	388	9,075	16,729
Algiers and Tunis	1883	166	8,964	16,365
New Zealand	1883	234	6,636	16,352
Switzerland	1883	1,236	6,743	16,335
Cape Colony	1883	....	5,246	15,738
Netherlands	1883	443	4,132	15,486
Cuba	1883	187	4,500	13,500
South Australia	1883	....	....	12,937
Egypt	1878	168	7,841	12,040
Portugal	1878	226	4,468	11,335
Victoria	1883	....	5,623	11,129
Denmark	1882	132	3,653	10,105
Roumania	1882	242	4,621	9,639
Guatemala	1882	63	3,114	9,542
Persia	1882	78	5,835	9,516
Indo-European	1882	84	4,683	9,301
Columbia	1880	....	2,960	8,880
Sumatra and Java	1880	84	5,887	7,546
West Australia	1880	....	2,549	7,500
Peru	1878	34	2,211	6,633
Greece	1878	100	4,667	5,743
Bosnia and Herzegovina	1878	68	2,492	4,758
China	1878	....	1,510	4,530
Bulgaria	1882	44	2,498	3,508
Phillipine Islands	1882	37	1,149	3,347
Servia	1882	60	2,252	3,258
Uruguay	1882	21	1,043	3,129
Honduras	1882	....	805	2,415
Porto Rico	1882	....	750	2,250
Costa-Rica	1882	....	727	2,181
Tasmania	1883	....	....	2,137
Cochin China	1883	....	1,692	1,944
Montenegro	1883	11	444	1,332
Orange Free State	1883	....	441	1,323
Nicaragua	1883	26	1,250	1,287
Venezuela	1883	....	539	1,247
Bolivia	1883	....	290	870
Luxemburg	1883	64	310	536
Transvall	1882	....	175	525
Paraguay	1882	....	72	216
Hawaii	1880	....	64	192

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The annual meeting of this association, for the election of officers, and the transaction of business was held at the house of the American Society of Civil Engineers No. 127 East 23d street, May 19th. The following officers were elected: president, Dr. Norvin Green; vice-presidents, D. H. Bates, Prof. A. E. Dolbear, Francis W. Jones; managers, Charles L. Buckingham, David

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Brooks, T. C. Martin, George M. Phelps, Jr., Prof. B. F. Thomas, W. D. Sargent; treasurer, Col. Rowland R. Hazard; secretary, Ralph W. Pope. The report of acting secretary T. C. Martin shows that although the Institute has only been in existence one year it has 279 members and associates in all parts of the country. The Institute has as yet no permanent home, but a proposition has been made to have the various scientific and artistic societies of this city unite in securing a permanent fire-proof building for their joint use. This is now being considered by a joint committee.

A committee was appointed to prepare a revision of the constitution and by-laws, with a view to rendering the organization better adapted to the needs of the electrical fraternity, and to increase the scope of its practical usefulness. The result of the labors of the committee will be laid before the Institute for approval at an early day.

On Wednesday May 20th at 10 a. m. a general meeting of the Institute convened for the reading of papers and their discussion by members present, Mr. Sidney F. Shelbourne occupying the chair. The first paper read was that of Mr. Frankland Jannus of Washington, on "The Protection of Electrical Inventions." Mr. Jannus pointed out the tendency of several recent decisions of the Supreme Court, in patent cases, and in view of the ground therein taken, strongly urged the importance of employing skilful and competent solicitors to prepare applications for patents, inasmuch as the examiner can only act on what is placed before him, and even if he sees that the applicant has omitted to claim the most important feature of the invention, it is no part of his duty to call attention to the omission. Formerly such omissions when discovered could be rectified by a reissue of the patent, but the Courts have now taken the ground that this cannot be legally done, except under very special circumstances. It is also necessary that the question of possible modifications be carefully considered, in order that the inventors rights be adequately protected.

An interesting discussion followed, during which members availed themselves of the opportunity to obtain correct information regarding patent-office methods and facilities, from the author of the paper, whose practical experience as a solicitor rendered his views of unusual value.

A paper on "The Cost of Mine Lighting" by F. P. Mills was read by the secretary. It was based upon the practical working of a Brush plant in a Michigan iron mine. Considerable difficulty had been experienced on account of the wires being broken by blasting, but so far as economy and efficiency was concerned the result was in every way satisfactory.

Mr. Edward P. Thompson read a paper on "The Electric Arc-Lamp Frictional Clutch." He attributed much of the irregularity of the arc-lamp to the faults of the ring-clutch now generally used. He then demonstrated by a model the working principle of a newly invented clutch, consisting of a spiral spring, through the coils of which the carbon-holder was permitted to slide with a gradual motion. The action was so perfect, as to elicit the applause of the audience. After a thorough discussion of the merits of the invention, a recess was announced, to permit the members and guests to partake of an elegant and substantial collation which awaited them in an adjoining room.

The afternoon session was resumed with Mr. Jannus in the chair.

Mr. E. P. Roberts, of Cheyenne, Wyoming, read a paper on "The Storage Battery in Commercial Use." This was of special interest for the reason that under the supervision of Mr. Roberts the secondary battery has been successfully adapted to incandescent lighting in Cheyenne to such an extent and for such a length of time that he feels entirely confident of its future. In giving the result of his two years' experience he expressed the opinion that storage batteries had been both praised and belittled too much; that the service could be made entirely satisfactory, but that he nevertheless preferred to employ the direct current from the dynamo wherever practicable. In reply to a question by Mr. Hamilton, Mr. Roberts stated that he believed about 75 per cent. of the energy expended was recovered, but had not made sufficient calculations to warrant him in giving such a result as authentic.

Mr. Frank L. Pope gave a brief summary of a paper by Prof. E. J. Houston on "The Delany System of Fac-simile Telegraphy," as owing to the lateness of the hour, it was deemed inexpedient to read it in full, and enter into a formal discussion of the subject. This closed the proceedings of the day. The meeting was an unusually successful and interesting one, and the discussions of the papers, which were participated in by many of the members present, elicited much miscellaneous information of value.

The papers read, together with the discussions which followed, will be published, and distributed to members, as each is revised and printed, instead of awaiting the completion of the entire work as heretofore.

THE AUTOMATIC SIGNAL TELEGRAPH CO. IN COURT.

Gen. Alexander Shaler was the president of the Automatic Signal Telegraph Co., and the owner of 291 of its shares, some of which were issued to him in payment for his services, a certain number being given him whenever a money dividend was declared to the stockholders. The Automatic Signal company having sold its property to its rival, the Watkins Automatic Signal Telegraph Co., for one-third of the capital stock of the latter, Gen. Shaler objected to the sale. He brought a suit in the Supreme Court to have it set aside, or for the alternative relief that 855 shares of the company of which he was president, remaining in its treasury, should be distributed to him and his fellow-stockholders, and that the shares of the Watkins company paid for the property purchased by it, should also be divided among the same persons proportionately to their several interests in the stock of the seller corporations. The two companies defended themselves on the ground that the sale was legal and that Gen. Shaler had no valid title to the stock of the Automatic Signal Telegraph Co. that was given him for his services.

The case was tried before Judge Andrews in Special Term, who rendered a decision to the effect that the sale of the property of the first-named corporation to the second named corporation was legal notwithstanding that a majority of the trustees of the one also formed a majority of the trustees of the other. Such a relation of the contracting parties one to the other, he says, does not of itself prove a fraud. He also holds that it was not necessary for the stockholders of the seller corporation to give their written consent to the sale at a meeting called for the express purpose of obtaining such writen consent, although that was decided to be the law in Reiff against the Western Union company. The decision in that case Judge Andrews says, was based on a printed copy of the statute in which a comma was misplaced. A certified copy of the original statute shows by its punctuation, in his opinion, that the legislative intent was that three-fifths of the stockholders of a corporation should approve of the sale of its property, either in writing, done anywhere, "or by vote at a general meeting duly called for the purpose."

Having thus disposed of Gen. Shaler's charge of fraud, Judge Andrews holds the defense, based on the ground that Gen. Shaler was not entitled to the shares issued to him by the Automatic Signal Telegraph Co. in compensation for his services, to be unsound. His conclusion is, therefore, that the Automatic Signal Telegraph Co. shall distribute among its stockholders its own stock held in its treasury, and also the Watkins Automatic stock received for the property sold by it.

REORGANIZATION OF THE POSTAL TELEGRAPH CO.

The scheme for the reorganization of the Postal Telegraph Co. may be accepted as an accomplished fact, the holders of over $9,000,000 worth of the bonds (out of a capitalization of $10,000,000) having signified their acquiesence in the plan prepared, which comprehends a capital in stock alone of $5,000,000, obtained as follows: $10,000,000 bonds at 35 per cent., $3,500,000; $10,500,000 stock at 5 per cent., $525,000; $700,000 cash at 105 per cent., $735,000; stock in treasury valued at $240,000; making a total of $5,000,000. It is claimed that this solution has been obtained chiefly through the efforts of Mr. John W. Mackay, who holds over $2,000,000 worth of the company's securities.

Judge Lawrence appointed A. B. Chandler and Henry Rosener temporary receivers of the Postal Telegraph and Cable Co., upon giving a bond in the sum of $75,000. The appointment of receivers was made by consent, in an action brought by Campbell C. Brown and Thomas Fleming against the company for the sequestration of its property. On the 15th ult. Messrs. Brown and Fleming recovered a judgment against the company by default for $105 368,45 upon a promissory note for $100,000 made in June, 1884, by the company to Mr. Henry Rosener, its second vice-president and general manager. The note was indorsed and assigned to Messrs. Brown and Fleming, but when payment was demanded it was not made.

THE "NOVELTIES" EXHIBITION.

The success of the electrical exhibition held last year at Philadelphia under the auspices of the Franklin Institute has led the Board of Managers to authorize the organization of an exhibition of novelties, to open on the 15th of September next, and to continue until Oct. 31. The exhibition buildings at 32d street and Lancaster avenue, will be utilized for this purpose. The exhibits will be restricted to such recent discoveries in the sciences, arts and manufactures as the committee may deem worthy of admission. The management has decided to return to the former custom of awarding medals and certificates as tokens of special merit. The nature of the exhibition indicates that there will doubtless be a considerable representation from the electrical field. Applications for space may now be made, and full information will be furnished by the Committee on Exhibitions, Franklin Institute, Philadelphia.

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THE LONDON INTERNATIONAL INVENTIONS EXHIBITION.

Electric lighting continues to form one of the most important and interesting features of great exhibitions, owing, primarily, to the reason that satisfactory artificial illumination can be obtained only by its use. At the present exhibition, which opened May 6, various companies appear not only as exhibitors, but contractors for lighting the buildings and grounds. The Chinese lanterns and colored lamps, which have heretofore maintained their position for ornamental purposes, rather than illumination of walks and cosy bowers, have finally disappeared. The cornices and angles of the buildings are now delineated by rows of incandescent lamps, which are expected to develop sufficient light to fulfill the requirements of romantic ramblers. Such spaces as are not reached by the rays from the buildings which enclose the grounds will be supplied with small groups and rows of lamps, so that the entire out-of-door area will at least be relieved from darkness. This division of the lighting has been installed by Siemens Brothers, under the direction of Sir Francis Bolton. A special plant of three large dynamos, driven by a Matthews compound three-cylinder engine, has been placed for this purpose in the western arcade. The dynamos are of the upright compound type, capable of supplying about 6,000 five-candle lamps. The armatures of these dynamos are not wound with wire, the conductors being copper bars, which are now used in all excepting the smallest dynamos made by Siemens Brothers.

Those who have closely watched the development of electric lighting must have observed that recent progress has tended more generally in the direction of increasing the efficiency of apparatus by scientific construction, rather than in the invention of novel devices. This is the natural progress toward ultimate perfection, and is the result of experience in various fields and under various conditions. There are, consequently, but very few exhibits which can now be brought before the public possessing the popular merit of novelty. The Maxim-Weston, the Brush and the Edison-Swan systems are well known both in Europe and America. The Thomson-Houston system, however, now makes its first appearance in England, where it will doubtless receive considerable attention on account of its favorable reputation in America.

The Sun lamp, exhibited by the Sun Lamp and Power Co., of London, combines to a considerable extent the peculiarities of the arc and incandescent systems. The light is, in the main, derived from a block of marble, which the arc heats to a high degree of incandescence. Being of considerable size, it serves as a reservoir of heat for a sufficient time to overcome the fluctuations which are attendant upon the action of most arc-lamps. The marble is practically consumed in about 30 hours.

The Varley Flexible Carbon Lamp embraces some novel features consequent upon the peculiar formation of the electrode, which requires a different system of mechanism from the ordinary arc-lamp, the carbon being wound in long lengths upon bobbins. It consists of a wick or cord formed from a number of carbon filaments braided together. In this lamp the arc, rather than the heated points, is the source of light, and it more closely resembles a flame than is the case with any other pattern of electric lamp. This feature is of little importance in itself, but it is claimed by interested parties, and apparently on good grounds, that, by this system, arc-lamps of moderate powers may be run at a much less proportionate cost than heretofore. The tests made by the commission at the Paris electrical exhibition showed that the average spherical illumination from 90 Brush lamps was one candle per 1·17 watts of energy measured between the terminals of the lamps, also that the larger the lamp the greater its economy. The 20 Varley lamps at the present exhibition are each worked with a current of 2·5 ampères, and an electromotive force of about 45 volts. They emit a light which is estimated at 200 c. p., indicating a return of one candle per ·56 watt. Accurate photometrical observations have not yet been made, but even if reduced one-half, the result would be very satisfactory. The lamps at the exhibition are arranged five in series, and four in parallel, and consume 4½ in. of carbon per hour.

The flexible carbons are paid out by feed rollers, actuated by clockwork, and pass through tubular guides to the horizontal arc. Suitable mechanism is provided, by which the carbons may approach each other or recede, according to the condition of the arc, which has a tendency to curve itself upwards. This is prevented by a small refractory porcelain block, which serves as a reflector, and confines the flame within more moderate limits.

The Varley lamps are so arranged that each may be served by a current from a Gaulard & Gibbs secondary generator. The object of this system is to permit of the transmission of a large amount of electrical energy through a small conductor, from which it may be diverted at various points in such quantities and under such conditions as required. Thus it is practicable to derive from a small main currents suitable for large and small arc-lamps, Jablochkoff candles and incandescent lamps, requiring an electromotive force varying from five to 100 volts or more.

Wherever one or more lamps of the same character are located, a secondary generator is connected in the circuit, and a portion of the main current is thereby caused to induce nearly an equal amount of energy in a local secondary circuit. The apparatus by which this result is attained is based upon the principle of the Rhumkorff coil, being made up of two separate coils and an iron core. The coils are wound side by side on the core. The alternating current, passing through the first, induces a current in the second at each pulsation. There was originally considerable skepticism as to the practical value of this system, but the inventors have persevered in their efforts, and have been so far successful that they were last year awarded the grand prize of 10,000 francs at the Turin exhibition. Experiments made by Professor Ferraris and others show that 95 per cent. of the energy of the primary is converted into the secondary current.

The long-cherished idea of a successful rotary engine has been given renewed interest by the development of electric lighting; and among the new candidates of this class is the Parsons motor, for which the claim is made that it wiil run steadily many thousands of revolutions per minute without undue consumption of steam. So many ideas of this character have, however, disappointed their advocates, as well as the steam-using public, that it will be wise to await official tests before placing any faith in popular rumor.

ELECTRIC LIGHTING IN VIENNA.

The electric lighting installation which has been fitted up in the houses belonging to the Union Building Co., near the new Town Hall, serves for lighting up the rooms of the café and the restaurant on these premises, for the arcades, and also for a private house.

The machines and steam boilers for working the installation are in the sunk story of the house I., Ebendorfer strasse 6, and include:

Three boilers, with smoke-consuming furnaces, on the Ten Brink system, consisting of one steam collector, three upper boilers, six lower boilers, and one Ten Brink ante-boiler. They have a pressure of six atmospheres and a heating surface of 63 square metres each. One of these boilers is for the electric light, one serves in winter to heat the building by means of steam pipes, whilst the third is a reserve. The steam engine is a high-pressure horizontal, with Corliss gearing, the diameter of the cylinder is 370 millimetres, the stroke 790 millimetres, and making 69 revolutions per minute.

The dynamos are impelled by a countershaft, connected by the engine with a hemp driving-band.

For the glow lights there are used four Edison machines, each for 60 lamps of 16-candle power, or 120 at eight normal candles.

These machines supply 142 B lamps at eight normal candles, and 37 A lamps at 16 candles for the café, 188 B lamps for the restaurant, about 60 B lamps in a private residence, and 13 A lamps in the machine and boiler house, making together 490 B lamps, all the lamps being reduced to the B standard. The machines make 1,200 turns per minute. The glow lamps are all Edison's. For the six arc-lamps which light up the arcades, two Gramme machines are in use, one of which supplies two lamps at 1,000 normal candles, and the other four lamps at 1,000 normal candles.

The former makes about 850 turns, and the latter 1,300 turns per minute. The power expended for the normal working of the entire installation is 52 h. p.

The café has been lighted without interruption since May 15, 1883, and the restaurant since April 3, 1885. The steam boilers and engine were supplied by the firm of E. Skoda, of Pilsen. The entire installation has been carried out by Brückser, Ross & Co.

On April 17 the engineer, J. Kolbe, explained the arrangements in fullest detail to his pupils from the Technological Trade Museum. The installation has worked faultlessly from the very beginning.—*Zeitschrift für Elektrotechnik.*

AN IMPORTANT GROUP OF PATENTS.

There has been quite a general impression, that the field of invention in printing telegraph apparatus, had been so thoroughly reaped, that it offered but little encouragement for the inception and development of original ideas. That such is not the case, is practically proven by the issuance of 23 United States patents on April 28th, to Mr. Henry Van Hoevenbergh, of New York and Elizabeth, N. J., for printing instruments, and various devices identified with their practical working. These patents have all been assigned to the Baltimore and Ohio Telegraph Co., of which Mr. Van Hoevenbergh is the electrician. We believe that it is generally admitted that this gentleman has no peer in this line of electrical invention, to which he has devoted the most attention. Although the electric light and telephone have to a considerable extent monopolized recent popular notice, there are various other channels of usefulness for electricity, and those who have been identified with it, since the time when its only public mission was that of telegraphic communication, will be pleased to learn that its original dominion is not to become either depreciated through neglect, or stifled by the rank growth of modern improvements.

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ELECTRIC GAS-LIGHTING CASE.

ELECTRIC GAS LIGHTING COMPANY *v.* SMITH & RHODES ELECTRIC COMPANY.

U. S. Circuit Court—Southern District of New York.

Decided March 16, 1885.

1. When a reissue is made between eight and nine years after the original, the specifications in the two patents being identical, it is not enough to support a new claim in the reissue that the inventor might have made the claim in the original patent; its subject-matter must have been claimed in some manner in the original or included within what was there claimed.

2. In this case the first claim in the original patent was for a circuit-breaker only, while the fifth claim of the reissue, which is sought to be founded on it, is for the machinery operating the circuit-breaker. As the claim in the original was not for a combination, the combination of the claim in the reissue cannot be said to be the same combination further restricted by additional elements. On reconsideration, it is *held* that the subject-matter of the reissue claim is not included in what was claimed in the original patent.

Mr. Edwin H. Brown for the orator.
Mr. Samuel B. Clarke for the defendant.

WHEELER, *J.:*

The only question presented in this case now was decided in *Electric Gas Lighting Company* v. *Tillotson* on the same patent. It is whether the fifth claim of the reissue is supported by the original, and has been reargued and reconsidered. The patent is for an electric gas-lighting apparatus. The foundation for this fifth claim is sought for in the original first claim. That was for a circuit-breaker located at the burner and operated automatically, substantially as described. This is for the combination of a wire through which a current of electricity is passed, actuating mechanism for letting on the gas, an electro-magnet connected with the wire, an armature operated by the magnet, mechanism, actuated by the armature, breaking the circuit at the burner and producing sparks for lighting the gas, the whole operating automatically. The specification is the same in both the original and reissue. The inventor might have claimed upon it everything which he has claimed; but that is not sufficient. *Manufacturing Company* v. *Ladd*, 102 U. S., 408. The reissue is between eight and nine years later than the original, and could not lawfully cover what was not either claimed in some manner in the original or included within what was so claimed. (*Mahn* v. *Harwood*, 112 U. S., 360.) This claim of the reissue is for machinery breaking an electric circuit at the burner and producing sparks there to light the gas. It may or may not include machinery for turning on the gas. The claim in the original was not for any machinery, but the circuit-breaker. It was for the circuit-breaker operated; but that did not include the machinery to operate it. If it included the operation, that is a different thing from the means by which the operation is performed. *James* v. *Campbell*, 104 U. S., 356; *Powder Company* v. *Powder Works*, 98 U. S., 136. So, whether this claim in the reissue includes the machinery for turning on the gas or not, it is for a part of the invention not claimed in the original (*Turner & Seymour Company* v. *Dover Stamping Company*, 111 U. S., 319); and as the claim in the original was not for any combination of parts, the combination of this claim of the reissue cannot be said to be the same combination further restricted by additional elements, and is not included in what was claimed in the original. The patent for the circuit-breaker as located and operating, and machinery for turning on the gas, without the machinery for operating the circuit-breaker, appears to have been satisfactory at the time when the patent was taken out, and for so long a time afterward, that it could not be made to cover the machinery for operating the circuit-breaker. The conclusion reached is the same as before.

Let there be a decree dismissing the bill of complaint.

THE HENRY MEMORIAL TABLET.

One of the features of the coming commencement at Princeton college will be the unveiling of the Henry memorial tablet, which is now being completed by a New York architect. President McCosh has decided to insert the tablet in the east wall of the Marquand chapel, north of the chancel, facing the nave. Invitations have been extended by the donors of this memorial gift to all the leading scientists in America to be present at the unveiling ceremonies on Tuesday, June 16. The tablet will be presented to the college by Mr. Dickerson, a prominent member of the New York Bar, with an appropriate address. It will be received for the college, with addresses, by president James Mc Cosh, Prof. Cyrus F. Brackett Henry, Professor of Physics, Prof. Charles A. Young, and Prof. J. Stillwell Schenck, the latter of whom assisted Prof. Henry in his laboratory work at Princeton college. Another address will be made by some leading scientist who has not as yet been selected. This memorial is the first that has ever been erected to any of Princeton's illustrious instructors. Prof. Joseph Henry performed most of his renowned experiments in electricity during his connection with this college. He used for his laboratory the cellar of old Philosophical Hall—now removed, and which formerly stood on the present site of the college library. In the museum of the physical laboratory is the largest electro-magnet Prof. Henry constructed, together with other of his machines, now having a great historic value.

THE CLAIMS OF THE EDISON ELECTRIC LIGHT CO.

The Edison Electric Light Co. of this city issued the following circular, May 23d, in regard to their legal claims to certain patents:

First—That the patents of Mr. Thomas A. Edison, now the property of this company, fully cover the exclusive manufacture, sale, and use of any and all practical incandescent electric lamps.

Second—That the Edison company, having begun suits at law for the enforcement of its rights under these patents, will not relax in their vigorous prosecution.

Third—That the Edison company is prepared to fully guarantee and protect all its customers, and to prosecute and punish, to the full extent of the law, all makers, sellers, or users of incandescent lamps not duly authorized by it.

The late attempt to establish for the Sawyer-Man patent, just issued, a fundamental character is made upon wholly superficial ground, and will not bear the test of close analytical examination. Edison's patent of January, 1880, applied for at the time of his great discovery, covers broadly all the elements of that discovery, and is therefore, fundamental and controlling. The Sawyer-Man patent, constructed in the light of the knowledge of 1885, but having for its foundation unsuccessful laboratory experiments, only covers certain details of manufacture of carbons, as, for instance, paper and the specific genus of material to which it belongs, and is therefore secondary and subordinate. The claim that the Sawyer-Man patent is fundamental, simply because the narrow and valueless claim to the use of paper has been illegally and without notice to Edison broadened to a claim for all fibrous material, carries its own condemnation. If anything more is necessary to demolish it, it may be stated that Edison, Swan, and others have already used materials absolutely non fibrous, in preference to a material the claim for which is now held to control the construction of a practical lamp. The public have nothing to fear from the use of the lamp as supplied by the original inventor and discoverer, while they render themselves liable for damages by the use of his fundamental patent for a "filament of carbon" if unauthorized by the Edison company.

THE EDISON ELECTRIC LIGHT CO., by EDWARD H. JOHNSON, Vice-President.

ANNUAL MEETING OF THE RHODE ISLAND TELEPHONE AND ELECTRIC CO.

The annual meeting of the Rhode Island Telephone and Electric Co. was held in Providence on the 6th ult. The report of the secretary and manager J. W. Duxbury, showed that subcompanies had been formed in Boston, New Bedford, Fall River, Taunton, Brockton, Worcester, Springfield, Pittsfield, Lowell, Lawrence, Lynn, Newburyport, Salem and Attleboro in Massachussets; and in Providence, Woonsocket, Pawtucket and Westerly, in Rhode Island; and that negotiations were pending in New Hampshire and Connecticut. The treasurer's report, showed a balance in excess of capital and liabilities of $35,000. They have paid during the year two dividends of four per cent. each, amounting to $8,000. The old board of directors was re-elected and also the following officers: President, Henry Howard; treasurer, Chas. T. Howard; secretary and general manager, J. W. Duxbury; assistant-general manager, F. H. Gardiner.

INCANDESCENT LIGHTING IN NEW YORK AND BROOKLYN.

During the past month an isolated plant of 350 incandescent lamps has been started by the United States company at the Hamilton club, Brooklyn. They are distributed in all parts of the building, gas being entirely dispensed with. An installation of the same extent is nearly completed in the Brooklyn *Eagle* building. The new ferryboats Colorado and Wyoming with Weston plants are now running.

The plant at the New York Post-office, comprising 1400 lamps, has been running satisfactorily for a fortnight, and has been examined and approved by Mr. Thomson the chief government inspector It comprises seven 200-light dynamos driven by one Porter-Allen and one Buckeye engine. This is the fifth post-office which has been fitted up by the United States company. The arc-lamps at the Coleman House are being superseded by the large Weston incandescents. They will be supplied with a current from the Stanton street station, two and one-half miles distant.

OWNERSHIP OF THE BALTIMORE AND OHIO RAILROAD TELEGRAPH CO.

A short time ago a bill was filed against the Baltimore and Ohio company by a stockholder in the road alleging that the railroad had no authority under its charter to maintain a telegraph organization, that the Baltimore and Ohio Telegraph Co. was detrimental to the stockholders of the railroad, and that the officers of the company were unduly interested in the telegraph. It concluded by praying for an injunction restraining the company from further maintenance of the telegraph company. This

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action bore some marks of having originated from a Western Union source. The answer of the railroad company, which was somewhat delayed, has been at last filed, and makes denial of all the allegations of the complaint. It declares that the company has authority to maintain the telegraph company, and that so far from being detrimental to the road, the telegraph company, which is being rapidly extended throughout the country, is fast becoming the source of a large revenue to the road; it is owned in toto by the Baltimore and Ohio Railroad Co., and no officer of the road is interested privately in it.

THE NEW YORK ELECTRICAL SOCIETY.

The meeting of May 13th took the form of a tour of inspection by the members of the society through the very complete electric lighting station of the United States Illuminating Co., at 34 Stanton street in this city. There can be no more effective impression produced of the growth of this new industry, than by visiting an important station of this character, where notwithstanding the immense aggregation of machinery the excellent arrangement of the engines and dynamos permits a close examination of every detail. The visitors were thoroughly pleased with their investigations which were not only instructive but exceedingly interesting.

The Electrical Society has removed to its new quarters at 234 Broadway, opposite the post-office. The library and reading-room are accessible to members every week-day, and on the second and fourth Wednesday evenings of each month the regular meetings will be held at the same place.

CONFERENCE OF TELEPHONE LICENSEES.

The American Bell Telephone Co. has issued invitations to all companies licensed under its patents to send delegates to a conference at Boston June 8th. The session will continue for five days, during which the delegates will be the guests of the parent company. It is supposed that a reduction in rentals to sub-companies will be considered, and possibly adopted, in view of the antagonistic legislation which is cropping out in various parts of the country.

ANNUAL MEETING OF THE NEW ENGLAND TELEPHONE CO.

On May 15th, the new board of directors of the New England Telephone Co. met and completed their organization by the election of an executive committee as follows: Theo. N. Vail, W. H. Forbes, Thomas Sherwin and Chas. J. Glidden, the latter in place of W. A. Ingham resigned. Three of the four gentlemen are officers of the American Bell Telephone Co., which company accordingly retains the executive management in its own hands.

CORRECTION.

Through a misunderstanding of the facts a foot-note to the article on Atmospheric Electricity in the May issue of this journal, stated that the author had been awarded the Jones prize at the New York Electrical Society. This was not the case, the official decision not having been made as yet.

THE ELECTRIC LIGHT ASSOCIATION.

The chairman of the executive committee of the National Electric Light Association announces a meeting of the committee to be held at Union Square Hotel in New York city, on June 9th at 10 o'clock a. m.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

The third annual meeting of Railway Telegraph Superintendents will be held at the Weddell House, Cleveland, Ohio, at 10 a. m., June 17th.

ELECTRIC LIGHT AND POWER.

Domestic.

The New Britain Schuyler Electric Light Co. has been incorporated in Connecticut, with a capital of $25,000.

The Mobile Electric Light Co., Mobile, Ala., is putting in a Thomson-Houston plant.

A Pittsburg corporation, known as the Duquesne Electric Co., was chartered at Wheeling, W. Va., April 28. The capital stock is $600,000, of which sum $2,500 has been subscribed.

The Jefferson Bain Electric Light and Power Co., of Chicago, has been incorporated, with a capital stock of $25,000.

The Commissioner of Patents has denied a motion for a rehearing in the patent interference proceedings of Siemens against Edison against Field. The matter at issue was a patent for the application of electricity as a motive power to railway cars by means of the rails, and the decision of the Commissioner sustains the findings of the Examiners in awarding priority of invention to S. D. Field, of New York.

The Edison Electric Illuminating Co., of New Brunswick, N. J., has been incorporated to construct and maintain works for the manufacture and supply of electricity for lighting, heating and power. Capital stock, $50,000.

The Pine Bluff Electric Light and Power Co, capital stock $25,000, has been organized in Pine Bluff, Ark., to build electric-light works.

The American Electric and Illuminating Co. is starting an electric-light station at Poughkeepsie. It will put in two Armington & Sims engines, a steel tubular boiler, which will be set with the Jarvis furnace to burn screenings and slack coal, also a National feed-water heater.

Messrs. Wm. B. Hayes, John E. Wyman and L. T. Griffin, of Detroit, have incorporated into the Van Depoele Construction Co., for the purpose of supplying the cities and towns of Michigan with electricity for light and motive power.

The Franklin Electric Light and Power Co., of New York city, has been incorporated for general purposes, chiefly manufacturing.

The Brush-Swan Electric Light Co., of Central New York, has been incorporated, with a capital of $150,000. It will enter at once into the business of both arc and incandescent lighting, having already bid for the street lighting of Utica, outside the "naphtha" district, for $19,500 per year.

The United States company has been awarded the contract for lighting the State Insane Asylum at Fulton, Mo., with 450 Weston 16-candle-power lamps.

The New Lots Electric Lighting Co., of New Lots, N. Y., has been incorporated to manufacture electrical appaaratus. Capital stock, $15,000.

Foreign.

The electric light is to be used on all the trains running through the St. Gothard tunnel.

It is reported that, at the forthcoming Antwerp exhibition, the commission will endeavor to establish units of work and of cost for each type of dynamo, and for each purpose to which it may be applied.

It is proposed to run electric tram-cars from Victoria bridge, London, to Battersea, provided permission can be obtained from the Board of Trade.

Messrs. Wheatley Kirk, Price and Goulty have instructions to sell by auction the plant and stock of the "Pilsen, Joel and General Electric Lighting Co." and of the "Electric Lighting Supply and Fitting Co."

MANUFACTURING AND TRADE NOTES.

Domestic.

The firm of A. K. Eaton & Co. has been formed for manufacturing and dealing in electrical, philosophical and optical instruments, at 65 Henry street, Brooklyn.

The electrical supply business of Wm. R. Pope & Co., of Baltimore, Md., has been assigned to James B. Guyton.

Paul Revere founded the copper works in Canton in 1800, which were incorporated as the Revere Copper Co., in 1828. During all these years copper was never so low in price as now, still the company manages to run regular hours, though not with their full force. Some of the great-grandsons of Paul Revere are now in the concern, and part of the house in which he lived is still in existence.

Foreign.

A firm in Glasgow, Scotland, is now manufacturing ribbon wire for electric purposes. It is nearly rectangular in section, and thus can be wound into a smaller space than round wire, while its greater flexibility renders it far more easy to manipulate. It is marked with the same numbers as the corresponding sizes of round wire, and is delivered on wooden bobbins.

MISCELLANEOUS.

Domestic.

An automatic electric steering apparatus constructed for the government steamer "Despatch" was tested on May 6th at Brooklyn.

A press despatch from Oil City, Pa., says that a column of gas from a large gas well in that vicinity was recently struck by lightning and ignited. It is still burning and will be difficult to extinguish.

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Foreign.

The English Admiralty has ordered that all the guns of every vessel leaving Chatham shall be supplied with arrangements for being discharged by electricity, and that several of the larger ships will be provided with the electric light.

The Triboulet system of photographing all the country as seen from a captive balloon is said to have succeeded well. A very small balloon carries up to the necessary height the photographic apparatus, the panoramic object-glass of which is provided with a valve which can be opened through an electric current managed by the operator, who remains on the ground. The impressions obtained are useful for military purposes.

The new clock dials on the tower of the general Post-office at Melbourne, Australia, will be made of cast-iron having hemispherical recesses so placed as to mark the hours, instead of the usual numerals. These cups will be nickle-plated inside so as to reflect the sunlight, forming bright points during the day-time. After dark each will be illuminated by an incandescent lamp, and on each of the hands will be placed a close row of smaller lamps. By this arrangement it is believed that it will be possible to read the time at a great distance.

THE TELEGRAPH.

Domestic.

On May 25 Judge Phelps, at Baltimore, signed a decree ordering the sale at auction of all the property of the Bankers and Merchants' Telegraph Co., upon the bill of complaint of Francis P. Stevens. The property is to be sold June 18.

By an unfortunate blunder of the train despatcher at Ashley, Pa., a collision between a locomotive and a freight train occurred near Wilkesbarre, Pa., on the Lehigh and Susquehanna division, May 16, by which two lives were lost.

Foreign.

China, which only six years since had but six miles of telegraph lines, has now completed a system by which Canton, the capital of Southern China, is brought into direct communication with the metropolis of the north.

Extensive preparations are being made in the British post-office department to meet the increased traffic expected from the adoption of the sixpenny rate for telegrams. It is expected that in the first year there will be an increase in the total number of telegrams of 30 per cent. Half a million pounds have already been expended for new poles, wires, instruments, etc. Over 20,000 miles of additional wires have been laid, and 1,200 extra operators, and over 1,000 new messengers, will be engaged.

THE TELEPHONE.

Frederick W. Watkins, president and chief owner of the Mutual Telephone Co., at No. 1 Broadway, New York, has made an assignment, without preference, to Bernard Metzger. The company was formed to exploit an acoustic telephone.

A bill limiting telephone rentals to $3 per month for single instruments, and $2.50 where more than one is used, has been passed by the House of Representatives in Illinois.

The Freeman telephone is now announced from Washington as the instrument which is to make trouble for the American Bell company, unless it is bought up at once.

INVENTORS' RECORD.

Prepared expressly for The Electrician and Electrical Engineer *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From April 7th, to May 12th, 1885 (inclusive).

Alarms and Signals:—*Burglar Alarm*, A. W. Hall, 315,139, 315,140, April 7; F. G. Lyon, 316,376, April 21; J. H. Hill & J. E. Babcock, 316,621, April 28. *Annunciator*, J. E. McDuff and J. F. Doherty, 315,313, April 7. *Electro-Mechanical Gong-Striker*, L. H. McCullough, 316,476, April 28. *Multiple Signal-box for Fire and Police Telegraphs*, same, 316,477. *Push-button*, T. C. Frenyear, 317,450, May 5. *Annunciator and Fire Telegraph*, C. K. Pevey, 317,569, May 12. *Call-box*, F. B. Wood, 317,912.

Clocks:—*Movement*, J. E. Carey, 316,112, April 21. *Pendulum Clock*, F. and O. Haenichen, 316,360.

Commutators:—*Switch or Circuit Controller*, E. Weston, 316,096, April 21. *Switch or Circuit-Breaker*, same, 316,097.

Conductors, Insulators, Supports and Systems:—*Underground Conduit for Conductors*, G. H. Benjamin, 315,225, April 7; A. E. Lytle, 315,954, April 14; W. Walter, 316,700, April 28. *Electric Coupling*, T. T. Smith, 315,673, April 14. *Lightning Conductor*, F. R. Upton, 315,679. *System for Transmitting Power*, W. L. Stevens, 316,076, April 21; E. Weston, 316,090. *Aerial Conduit for Wires*, D. B. Macquarrie, 315,526, April 14. *Fire-telegraph System*, L. H. McCullough, 316,474, April 28. *Non-interfering Fire-telegraph System and Apparatus*, same, 316,475. *Insulators*, H. Kellogg, 315,633, April 14; H. Prenzel, 315,660, J. Locke and W. Bowker, 316,469, April 28; 316,812, W. H. Wright, 317,479, May 5. *Support for Underground Lines*, S. J. Fague, 317,326, May 5. *Vulcanization of Rubber Coverings for Conductors*, J. J. C. and M. Smith, 317,587, May 12. *System of Distribution*, W. S. Andrews, 317,700. *Conductor for Wire Fencing*, C. Williamson, 317,908.

Dynamo Machines and Motors:—*Motor*, C. G. Perkins, 315,161, April 7; F. J. Sprague, 315,179, 315,180. *Motor and Generator*, same, 315,181, 315,182. *Electro-Dynamic Motor*, same, 315,183. *Motor*, E. Weston, 316,091, 316,092, 316,093, April 21. *Governor for*, W. M. Thomas, 316,500, April 28. *Reciprocating Engine*, C. J. Van Depoele, 317,249, May 5. *Dynamo*, C. F. Heinrichs, 317,779, May 12. *Armature for*, W. F. Buckley, 315,903, April 14. *Regulator for*, E. Weston, 316,089, April 21.

Galvanic Batteries:—A. Haid, 315,937, 315,938, April 14; E. Bazin, 316,436, April 28. *Rotary Battery*, same, 316,437. *Battery Fluid*, I. L. Roberts, 317,206, May 5.

Ignition:—*Fire-arm*, F. E. Kinsman, 317,545, May 12. *Gas lighter*, E. H. Wright, 316,428, 316,429, April 21; J. A. Norton, 315,057, April 7. *Gas-lighting Apparatus*, same, 315,055, 315,056. *Cartridge for Electric Fire Arms*, 317,409, May 5.

Lamps and Appurtenances:—*Arc-Lamps*, W. F. Buckley, 315,473, April 14; M. N. Lynn, 315,524, F. M. Sparrow, 315,564, April 14; G. A. Tabourin, 315,571, L. Colburn, 316,240, April 21; C. F. Heinrichs, 317,777, 317,778, M. G. Farmer, 316,765, W. W. King, 316,791. *Incandescent Lamps*, E. Weston, 316,094, C. H. F. Muller, 317,171, May 5; T. A. Edison, 317,631, 317,632, 317,633, May 12; W. E. Sawyer and A. Man, 317,676. *Filament for*, W. Stanley, Jr., 316,302, April 21. *Holder for Incandescent Lamp*, P. H. Brangs, 316,003, April 21; E. Weston, 316,088. *Bracket*, same, 316,095. *Electric Light Apparatus*, T. T. Smith, 315,674, April 14. *Safety-box for Circuits*, W. L. Stevens, 316,077, April 21. *Electric Lighting System*, E. Weston, 316,707, 316,708, 316,709, April 28, *Automatic Cut-out for Incandescent Lamps*, W. M. Thomas, 316,501, 316,502. *Apparatus for Carbonizing Incandescents*, O. A. Moses, 316,993, May 5. *Electric Lighting System and Switch*, W. S. Andrews, 317,610, May 12. *Apparatus for Making Curved Carbons*, C. F. Heinrichs, 317,776. *Wiring Interiors for Electric Lights*, L. Stieringer and J. H. Vail, 317,879.

Metallurgy:—*Magnetic Separator*, C. F. Hilder and E. Scott, 315,028, April 7. *Apparatus for Refining Copper by Electrolysis*, M. G. Farmer, 315,265. *Apparatus for Obtaining Aluminum*, M. G. Farmer, 315,266. *Apparatus for the Separation of Gold from its Ores*, E. P. Thompson, 317,245, May 5. *Apparatus for the Electro-deposition of Gold from its Chlorides*, same, 317,246.

Miscellaneous:—*Means for Adjusting Armature Springs*, J. F. Gilliland, 315,017, April 7. *Means for Re-setting Armature Drops*, C. W. Holtzer, 315,035. *Passenger Recorder*, A. Torrey and D. J. Casey, 315,855. *Apparatus for Transmitting to Moving Objects*, L. Goldberg and A. L. Fyfe, 316,139, April 21. *Induction Machine*, P. Haerry, 316,143. *Driving Apparatus for Centrifugal Machine*, A. Watt, 316,316, 316,317, April 21. *Coil for Induction and other Electrical Apparatus*, L. Gaulard and J. D. Gibbs, 316,354. *Elevator*, S. S. Wheeler, 10,585, Re-issue. *Induction Coil*, T. J. Perrin, 316,817, April 28. *Weighing and Recording Device*, E. H. Amet, 317,432, May 5. *Glass Cutting Machine*, P. Lange and E. Lindiner, 317,805, May 12. *Compressed Air and Gas Locomotive*, D. S. Troy, 317,891. *Gas Engine*, same, 317,892. *Velocipede*, same, 317,893.

Railways and Appliances:—*Railway*, B. Bidwell, 315,113, April 7; F. J. Sprague, 317,235, May 5. *Circuit for Switch Signals*, A. W. Hall, 315,498, April 14. *Rail Connection*, H. D. Winton, 315,586. *Alarm for Trains*, S. C. Pullman, 315,662. *Signaling Apparatus*, W. Hadden, 315,772. *Railroad Signal*, J. Hinds and L. L. Stimpson. *Conduit for Railway*, E. Samuel, 315,841, T. C. Clarke, 317,302, May 5. *Mechanism for Automatically Operating Throttle and Brake Valve of Locomotives*, T. Potter, 316,171, April 21. *Alarm and Signal*, H. C. Roome, 316,183, April 21. *Signaling Apparatus*, C. D. Tisdale, 316,201. *Track Instrument*, H. D. Winton, 317,910, May 12. *Signal*, same, 317,911.

Storage Batteries:—E. T. Reichert, 315,339, 315,340, April 7; W. A. Shaw, 316,407, 316,408, 316,409, April 21. *Primary and Secondary Battery*, G. Fournier, 316,533, April 28. *Accumulator*, J. J. Barrier, F. Tourveille, and J. E. Legay, 317,487, May 12.

Telegraphs:—*Autographic*, S. P. Denison, 315,391, 315,392, April 7. *Induction Apparatus for Telegraphy*, J. C Ludwig, 315,425. *Current Reversing Key*, same, 315,426. *Polarized Relay*, same, 315,427. *Generation of Induced Currents*, same, 315,428. *Harmonic Printing Telegraph*, G. A. Cardwell, 315,121, 315,122. *Relay*, F. Stitzel and C. Weinedel, 315,568, April 14. *Sounder*, J. F. Gilliland, 315,763. *Transmitting Apparatus*, P. B. Delany, 316,125, April 21. *Receiving Apparatus for Synchronous Telegraphy*, same, 316,126. *Synchronous Telegraphy for Fac simile Transmission*, same, 316,754, April 28. *Printing Telegraph*, A. B. Smith, 316,494, H. Van Hoevenbergh, 316,677, 316,678, 316,679. *Electro-Magnet for*, same, 316,676. *Type-wheel for*, same, 316,682, 316,683, 316,684. *Platen-shifting Device for*, same, 316,685, 316,697. *Pneumatic Winding Apparatus for*, same, 316,688. *Automatic Governor for Transmitter*, same, 316,687. *Method of Unisoning Instruments having two Type-wheels*, same, 316,690. *Unison Device for Printing Telegraphs*, same, 316,855, 316,691, 316,696. *Inking-roller for*, same, 316,692. *Page-printing Telegraph*, same, 316,680, 316,681. *Chemical Printing Telegraph*, same, 316,689. *Chemical or Fac-simile*, same, 316,693. *Method of Printing Telegraphically*, same, 316,694. *Winding Device for Printing Telegraphs*, same, 316,695. *Receiver for*, same, 316,698. *Relay*, G. W. Gardinier, 316,956, May 5.

Telephone Systems and Apparatus:—*Signaling Apparatus and Circuit*, F. Herzog, 315,027, April 7. *Angle Hanger for Acoustic Telephone Line*, H. Seligman, 315,078. *Switch-board*, T. J. Perrin, 315,331. *Exchange Circuit*, same, 315,334. *Apparatus for the Transmission of Messages by Electricity*, G. T. Woods, 315,368. *Automatic Call for Latent Signal Transmitters*, F. B. Herzog, 315,783, April 14. *Bell for same*, same, 315,941. *Microphone*, H. E. Waite and S. H. Bartlett, 316,204, April 21. *Relay*, J. H. Clarke and G. W. Millard, 316,238. *Multiple Switch-board*, T. J. Perrin, 315,332, 315,333, April 7; 315,658, April 14; 316,394, 316,395, April 21. *Transmitter*, M. G. Farmer, 316,133. G. W. Drawbaugh, 316,883, April 28; 317,445, May 5; J. E. Fuller, 316,888. *Exchange System*, W. H. Preece, 316,911, April 28. *Portable Telephone*, O. H. Saxton, 317,213, May 5. *Revolving Telephone Stand*, E. F. Weaver, 317,252, May 5. *Telephone Circuit*, H. S. Thornberry, 317,888, May 12. *Flexible Tip for Conducting Cords*, G. K. Thompson, 317,887. *Telephone*, L. DeLocht-Labye, 315,421, April 7; W. L. Voelker, 315,862, April 14; H. E. Waite and S. H. Bartlett, 316,205, April 21; H. E. Waite, 316,206; E. T. Greenfield, 316,260; T. J. Perrin, 316,316, 316,818.

Expired Patents:—A list of the more important electrical patents which will expire during the current month, is subjoined:—C. F. Varley, *Use of Condensers in Cable Telegraphy*, 78,495, June 2.—J. B. Stearns, *Duplex Telegraphy*, 78,547, 78,548, June 2.—W. G. Bronson, *Telegraphic Repeater*, 78,573, June 2.—L. C. Stuart, *Electric Motor*, 78,619, June 2.—W. Wickersham, *Electric Motor*, 78,629, June 2.—C. T. Mason, *Electric Fan*, 78,674, June 9.—C. F. Varley, *Electro-Pneumatic Dispatch and Tube System*, 78,845, June 9.—H. J. Smith, *Electric Fuse*, 79,268, June 23.—C. Durant, *Self-Adjusting Relay Magnet*, 79,330, 79,331, June 30.—E. Blunt, Jr., *Electric Burglar and Fire Alarm*, 79,440, June 30.

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NEW YORK, JULY, 1885.

THE EDISON ELECTRIC LIGHT PATENTS.

IN commenting in our last issue upon the claim which has been put forth by the Edison Electric Light Co., that the patents of Mr. Edison are such as to "fully cover the exclusive manufacture, sale and use of any and all practical incandescent electric lamps," we expressed the opinion that these pretensions would prove to be untenable, and that the manufacture and sale of incandescent lamps could not be summarily monopolized in this manner. In order that our readers may have some idea of the grounds upon which our opinion was based, we have prepared, and publish in another column an analysis of the principal claims of the three incandescent lamp patents which are mainly depended upon to establish the exclusive claims of Mr. Edison, together with the text of the patents, and a summary of certain provisions of the patent law and decisions of the courts, which are likely to have an important bearing upon these particular patents. We have given also the principal facts in relation to the prior discoveries and inventions of others, and other information, which, it is thought, will enable the reader to understand the probable nature of the defenses which will be set up in the course of the pending litigation.

No one can be more ready than ourselves to admit the fact that the present advanced state of practical and commercial incandescent electric lighting owes a great deal, directly and indirectly to Mr. Edison. Nor can anyone have a higher appreciation of the ingenuity, industry and exhaustless perseverance which has been manifested by Mr. Edison in the development of his electric lighting system, and especially of the peculiar ability which he has shown in inspiring capitalists with that implicit faith in his inventive abilities, in default of which the present development of domestic electric lighting would doubtless have been postponed for years, simply from the lack of adequate financial backing. It would be superfluous for us to comment upon the perfection with which the apparatus in its mechanical and scientific details has been worked out. It is in operation in every part of the world and speaks for itself. But while awarding a proper share of the credit of the general result to Mr. Edison and his associates, it is but right and just that the work which has been contributed by others should meet with at least a fair share of recognition. Other inventors were in the field long before Mr. Edison, and their contributions towards the ultimate result, were certainly as important if not more important, than his own. In fact Edison's work could not have been carried to a successful result, had he not freely availed himself of the discoveries and inventions of Gramme, Alteneck and Weston, in dynamo-electric machines, of Farmer in the regulation and distribution of electricity, and of Geissler, Sprengel, Crookes and Gimingham, in the conduction of electricity through high vacua, and the improvement of the mercurial air-pump. Other inventors founding their labors upon the researches of these same predecessors have developed systems of incandescent lighting, certainly not inferior to that of Edison in efficiency, economy, and general adaptibility to general purposes.

It is just at this point that we take issue with the policy which has been pursued by Mr. Edison and the Edison company. In his patents Mr. Edison has asserted, and his company now proposes to undertake to enforce, his exclusive right to make, sell, and use incandescent lamps. As we have already said, we do not believe that this claim can be sustained. We entertain no doubt that if Mr. Edison had been contented to confine his claims strictly to the improvements which were actually made by him, instead of endeavoring to include not only what he had done himself, but everything which had been done by others as well, the situation might have been very different from what it is at present. But in his eagerness to monopolize the entire art of incandescent electric lighting, he is apparently in danger of finding himself in the situation of the dog in the fable, who lost the bone he had in his mouth by trying to assert his claim to the other bone which he saw reflected in the water. What ultimately became of the bone ; whether it was captured by another dog or not, the fable does not state, nor can we forecast the result of the present proceedings with much greater certainty.

THE IMPORTANCE OF SCIENTIFIC TRAINING.

ALTHOUGH there is abundant evidence at the present time of the existence of a widespread interest in electrical investigation, either as a study, a recreation, or a means of livelihood, there are frequent manifestations of a desire on the part of persons in whom the commercial instinct has been abnormally developed, to secure the skill, the knowledge and the experience which is possessed by the expert, without that essential preliminary training, which is popularly, and correctly, supposed to be obtainable only through many years of study and experiment, accompanied with a large proportion of hard work. In every branch of handicraft there will be found a large proportion of workers who do not believe in "the books," and who neglect no opportunity to publicly declare their views. They are men

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who prefer in every case to derive wisdom from their own experience, rather than profit by the researches of others. This is to a certain extent perfectly right and proper; yet life is too short at the best for any one of us to learn every detail of a profession by personal experience—to prove by the hard test of actual failure, and consequent loss of time and money, that a certain method of procedure is radically wrong, when that information might have been just as satisfactorily obtained by studying the investigations of others in a similar field.

In the early stages of electrical industry the science was in a comparatively crude state. Electricity was looked upon as a mysterious and uncertain agency, for the simple reason that its laws were comparatively unknown. Although a few scientists had investigated it as an interesting branch of physics, those who were called upon to deal with it commercially were not only almost entirely ignorant of its peculiarities and its possibilities, but were unable to solve its problems, simply for the reason that the lapse of time was necessary in order that experience might develop its various characteristics.

Electrical science stands to-day upon an entirely different footing. The literature of the subject is rapidly—perhaps too rapidly—multiplying in every branch. Not only are its fundamental laws thoroughly understood, but its exact capabilities and economies, down to the very acme of refinement, may be demonstrated by well-established methods, perfectly accessible to all who have sufficient faith in the value of scientific research to familiarize themselves with them.

There are not a few who are considered intelligent men, who believe that theory and practice are separated by an impassable gulf, and who look upon the literary work, even of a thoroughly practical man, as the mere vaporings of an enthusiast.

Scientific study and training are deemed an indispensable foundation for the career of the successful physician or civil engineer. It is certainly no less essential for the electrical engineer, and the time is rapidly and certainly approaching when the financial success of all enterprises depending upon the most economical transmission of electrical energy will demand the supervision of men who not only possess practical experience, but who are thoroughly versed in the progress of the art, both at home and abroad.

We have reason to believe that there exists in many quarters a disposition to ridicule the treatment of practical electrical work from a scientific standpoint, and to assert that the attainment of the highest degree of electrical knowledge does not necessarily involve a resort to mathematics or text-books. The early workers in the telegraphic field groped in the darkness, because of their excusable ignorance of the subtle agency with which they had suddenly been confronted. The telephone service developed a multitude of new investigators, many of whom ostentatiously ignored the long-established rules of conductivity, resistance and insulation. There were those who stood high in the service who held that the smaller the conductor the better the result, because of the diminished inductive effects, while the matter of insulation was of no importance whatever. Even the sleet-storms, which the old-time telegraphers had learned by experience to dread, were considered a mere bugaboo. A few years of practical experience have changed all this, and we find to-day that the electrical laws which were recognized as governing telegraphic conditions are admitted to be equally applicable to the telephone. The same may be said of the more powerful dynamic currents with which we are now becoming familiar. To be sure the field is extending, and the thorough electrician must soon extend his researches beyond the confines of his own territory into the domain of mechanical and civil and marine engineering. Those who would attain that complete knowledge of their profession which will surely lead to success, must seek to acquire the necessary stock of information to aid in equipping them for the task. While many practical workers are to-day standing aghast at the apparently incomprehensible array of equations, formulæ and tables, which, because they do not understand, they consider to be useless, the well-trained young graduate from the polytechnic school is entering the field, with a mental equipment which enables him, after a short practical experience, to secure those higher positions which must necessarily be filled by electrical engineers who are masters of their profession. The machinery which is now being brought into use, and the electric currents which are employed in connection with it, are matters not to be trifled with. Ignorance cannot be tolerated, for the consequent damage to property and life, as well as the adoption of inefficient and expensive methods, will surely absorb the profits, which are already too small to permit of any waste. The inexorable laws of commercial competition are certain, in the end, to crush out the ignorant and the incompetent, and to leave the trained and skilful expert master of the field.

ELECTRIC LIGHTING SCHEMES.

Among the many devices resorted to in modern times for obtaining money under false pretences, we know of none more reprehensible than that of forming corporations, the sole object of which is in reality the advancement of the pecuniary interests of their promoters and manipulators. Electrical enterprises, and especially electric lighting, have offered an uncommonly fine field for such enterprises, and now that the larger cities have been thoroughly worked up, we observe that very special attention is being devoted to the rural districts.

In order to entice the unwary investor a schedule is prepared, in which the fullest details are apparently given respecting the cost of plant, the running expenses, and, most important of all, the net profit, which, in certain cases within our knowledge, has been placed at over 50 per cent.

It is difficult to imagine upon what basis such a statement of profit can be figured out.

We are quite well aware that whatever we may say in reference to these fallacious statements will not be very likely to reach the future victims of these delusive enterprises; but we regard it as anything but conducive to the permanent interests of electrical industries that such schemes should be continually cropping out in various forms, and under different aliases, that each promoter should endeavor to befog the mind of the public with vociferous statements that his concern is the original Jacobs, and all others spurious imitations, unworthy of

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public confidence. Practically, both the arc and incandescent systems of electric lighting, in a general sense, have been freely open to competition. There are, of course, numerous improvements and economical devices, owned and controlled by different interests; and in the earlier periods of electric light development there were no doubt plenty of opportunities for obtaining large profits, by reason of the ignorance of purchasers as to the state of the art. All this is now changed, and we find that in most installations of any importance competitors are invited to submit proposals for contracts to be awarded to the lowest bidder. It is not our purpose to assert that this state of affairs is the most beneficial one, either to the vender or the public, but simply to emphasize the fact that there is no legitimate foundation for the expectation that large profits can be realized by the introduction of electric lighting systems, especially in small towns. It is, no doubt, true that in many cases exclusive franchises may be obtained in very favorable localities, which may lead up to a fairly profitable business, returning dividends possibly of eight or ten per cent. If there are any local companies which have done better than this, and at the same time laid aside a reasonable margin for the renewal of plant, or for placing their wires underground, we should be pleased to learn the details of a system which has thus proved itself in every respect a satisfactory business investment. We see no reason why a statement of the exact facts should be detrimental to the healthy development of the electric lighting industry. If it is desirable to obtain the good will of the public, claims of exorbitant profits will not be likely to prove advantageous, while if it is true that immense gains may be realized, we think that the privilege of obtaining them should be reserved for the benefit of that select circle of friends who are entitled to admission on the ground floor.

IMPORTANT DUPLEX TELEGRAPH LITIGATION.

The duplex telegraph, which was introduced on the lines of the Franklin Telegraph Co. in 1868, and on those of the Western Union in 1872, was never commercially successful until after the addition to the original apparatus of a condenser for neutralizing the electro-static effects which are manifested upon long lines. A patent for this improvement was granted to Joseph B. Stearns in 1872, and was purchased by the Western Union Telegraph Company. It is the ownership of this patent more than anything else which has enabled the Western Union company to maintain for more than a dozen years, a virtual monopoly of duplex and quadruplex telegraphy.

During the past year the Baltimore and Ohio company is understood to have made extensive use of the condenser in connection with its duplex and quadruplex circuits. The Western Union company, on June 22d, made application for an injunction against the Baltimore and Ohio Telegraph Co., its agents and employés, alleging an infringement of the Stearns patent. The motion was to have been heard on June 26th, but has been postponed for three weeks.

This will probably prove to be one of the most important patent suits which has ever occupied the attention of the courts in this country. It is no exaggeration to say that the Stearns invention has been worth many millions of dollars to the Western Union company, and the result of the proceedings will be awaited with the greatest interest in telegraph circles. It is not known what line of defense will be adopted by the Baltimore and Ohio company, but inasmuch as the action has been commenced on a reissue which was taken out nine years after the date of the original patent, it is not difficult to conjecture that in view of many recent decisions of the Supreme Court, one of the principal defenses will be that the reissued patent is invalid. Assuming the patent to be valid there would seem to be little doubt of the fact of infringement, provided the Baltimore and Ohio company makes use of the condenser in connection with an artificial line, as it may be presumed that it does.

Messrs. Buckingham, Dickerson and Duncan appear as attorneys for the Western Union, and Messrs. Lowrey and Bacon for the Baltimore and Ohio.

THE TELEPHONE CONFERENCE.

The recent gathering of representative telephone men in Boston took the form of a private business conference, at which views were freely exchanged as to the proper policy to be pursued in order to obtain the best financial results, and at the same time appease a certain tangible, though not altogether well-defined feeling of enmity against the home company, which has gradually become so considerable as to be worthy of attention.

In offering explanations to the subscribers for the exaction of the prevailing rates, which vary all the way from $20 to $150 per annum, according to the circumstances, the royalty paid for the use of the instruments has been one of the most convenient pretexts, because it has served to relieve the local managers from the imputation of oppressing their friends and neighbors. This was a very natural thing to do, and as the officers of the American Bell Telephone Co. were securely intrenched behind the convenient shield known as a board of directors, no particular harm was done, until antagonistic statutes began to be enacted by the various state legislatures. The result of all this agitation has been a reduction of one-half in the royalty—from $12 to $6 per year—also the abolition of the rental of central office telephones. This change may perhaps not be universal, as our information on the subject is somewhat meagre; but at all events, certain concessions were made, which under the seductive influence of boundless hospitality, appear to have been generally acceptable to the guests of the alleged "monopoly." Whether the rural telephone subscriber is to be permitted to share in the benefits of the new schedule, will doubtless be a question for future consideration. When he inquires into the matter he will without difficulty ascertain that the visiting statesmen had a good time; but if he presses for further information, the conversation may assume substantially the form of that in the beautiful lines of Southey, so familiar to every schoolboy:

> "And everybody praised the duke
> Who this great fight did win.
> 'But what good came of it at last?'
> Quoth little Peterkin.
> 'Why, that I cannot tell,' said he,
> 'But it was a famous victory.'"

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ARTICLES.

AN ANALYSIS OF SOME OF THE EDISON PATENTS FOR ELECTRIC LIGHTING.

A PUBLIC notice was issued on May 23d, 1885, over the signature of the vice-president of the Edison Electric Light Co., in which it was stated that the patents of Mr. Edison "fully cover the exclusive manufacture, sale and use of *any and all* practical incandescent" lamps, and that the Edison company is prepared to "prosecute and punish to the full extent of the law all makers, sellers and users of incandescent lamps not fully authorized by it."

In an earlier official publication by the same company, dated July 27th, 1882, it was definitively stated that the following points, among others, were broadly covered by Mr. Edison's patents:—

1. An electric lamp having a continuous conductor (without regard to its material, resistance or mode of preparation) and an exhausted glass enclosing globe.
2. An electric lamp having a continuous carbon conductor (irrespective of its material, resistance or mode of preparation) and an exhausted glass enclosing globe.
3. A filament of carbon of high resistance secured to metallic conductors (*i. e.*, the leading-in wires).

It is proposed in the present article to make an examination of the three patents which appear to be regarded by the Edison company as the essential ones upon which these alleged exclusive rights are based. These are as follows:—

No. 223,898, dated January 27th, 1880.
No. 227,229, dated May 4th, 1880.
No. 265,777, dated October 10th, 1882.

Before proceeding to examine these three patents on their merits, it may be pertinent to remark that under the provisions of section 4,887 of the Revised Statutes of the United States, there would seem to be little doubt that they have already become public property in this country.

The text of the statute referred to is as follows:—

Every patent granted for an invention which has been previously patented in a foreign country, shall be so limited as to expire at the same time with the foreign patent, or if there be more than one, at the same time with the one having the shortest term.

It has been decided by the United States Courts that an American patent expires at the same time with a foreign patent, when issued there before it is issued here, though the American application was filed first, and though the foreign patent may afterwards be extended for an additional term of years.[1] This question first arose in reference to the effect of a prior Canadian patent in limiting the term of the American patent, and it was held that the expression, "patented in Canada," means the date of grant and issue, not the date of delivery to the patentee. In the Gramme case[2] the same doctrine was reaffirmed with respect to a prior Austrian patent which had been taken for one year, and subsequently extended for nine years, but had expired.

It is proper to state that the question involved in these two cases has yet to be passed upon by the Supreme Court. While we regard this law as an absurd relic of barbarism, and would be glad to see it swept from the statute books, we look for the needed relief to come from Congress and not from the Supreme Court.

The records show that the subject-matter of Edison's patent No. 223,898, of January 27th, 1880, was patented in Canada as No. 10,654 on November 17th, 1879, for a term of five years. Under the statute, therefore, this patent expired November 17th, 1884. The same invention was also patented in Italy for six years on December 6th, 1879.

The subject-matter of Edison's patent No. 227,229, of May 4th, 1880, was patented in Italy for six years on June 23d, 1879, and its term commenced to run on June 30th, 1879. Hence this patent, under the provisions of the statute, expired on the 30th of June, 1885.

The subject-matter of Edison's patent No. 265,777, of October 10, 1882, was patented in Austria, August 3, 1881, and it expired in that country, and consequently in the United States, on the 3d August, 1883.

Hence it appears that, under the provisions of the statute referred to, every one of these three so-called "fundamental patents" of Edison is now public property, and may freely be used by any one, so far as the Edison Electric Light Co. is concerned.

Leaving this aspect of the case out of consideration altogether, there would appear, moreover, to be good reason for the opinion that the patents are intrinsically invalid for want of novelty, or by reason of unpatentable subject-matter. As this subject is of considerable importance, it is proposed to discuss it at some length. The three patents will be considered separately, in the order of the dates on which they were respectively filed in the United States Patent Office.

UNITED STATES PATENT OFFICE.

Thomas A. Edison, of Menlo Park, New Jersey.

ELECTRIC LIGHT.

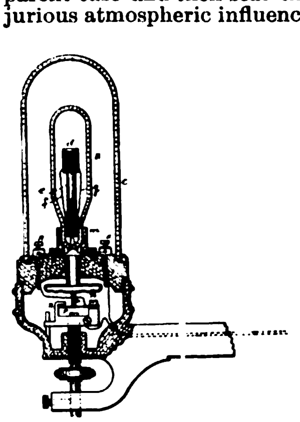
Specification forming part of Letters Patent No. 227,229, dated May 4, 1880. Application filed April 21, 1879.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the State of New Jersey, have invented an improvement in electric lights (Case No. 176), of which the following is a specification.

When platina and other metals that fuse at a high temperature are exposed to high heat and then cooled in the atmosphere they are injured, so that they are not well adapted to use in electric lights for a long period of time.

I inclose the conductor that forms the electric candle in a transparent case and heat the same gradually to expel any gases from the material of the candle. I form a vacuum in the transparent case and then seal the same hermetically, so that all injurious atmospheric influences are avoided.



The invention further consists of a vacuum-receptacle made entirely of glass and sealed by melting the same in combination with an incandescent continuous conductor pyro-insulated.

The invention further consists in winding pyro-insulated wire upon a bottom of a compressed infusible substance, such as lime.

The invention further consists in placing the vacuum-bulb within another glass receptacle, also closed from the air, and employing the expansion of the air between the two receptacles due to the heat of the incandescent bobbin to produce a movement which shall disconnect the lamps from the electric circuit when its temperature is too great.

The drawing shows a section of the apparatus, in which B is the transparent bulb. This bulb is open at the smaller end and the burner *d* inserted, and the open end of the tube is placed in connection with a mercury vacuum-pump, the platina wires *g* and *f* passing through. The burner is connected with a battery and variable resistance coil while the vacuum is being made. The heat of the bobbin *d* is, in the course of one hour, brought gradually from the temperature of the air to vivid incandescence. When the vacuum is considered practically perfect the open end of the tube is melted and sealed. The platina wires passing through the glass are also sealed.

Thus I am enabled to obtain a nearly perfect vacuum, which is permanent, and at the same time give the platinum wire a new and unknown property of great value in electric lighting, which is, that a platina wire which melts in the open air at a point where it emits a light equal to 4 candles will, when operated upon as described, emit a light equal to 25 candles without fusion. The reason why the melting-point of the metal is thus raised is, that in the act of making the vacuum with the metal under heat all the gases which are contained in its pores are withdrawn, and when the receptacle is sealed cannot re-enter when cold; hence unequal and sudden expansions cannot take place and the wire is never cracked, but if left uncovered becomes as bright as the most polished silver—an appearance which cannot be given it in any other way. On the other hand, it is known that the metals of the platinum group have, in a surprising degree, the peculiar

1. Bate Refrigerator Co. *v.* Gillett, 22 Off. Gaz., 1,205.
2. Gramme Electrical Co. *v.* The Arnoux-Hochhausen Electric Co. *et al.*, 25 Off. Gaz., 193.

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power of absorbing within their pores many volumes of gas, and it is the sudden expansion of this gas upon a sudden accession of heat that disrupts the wire and produces cracks, which extend nearly to its centre when the wire is brought to moderate incandescence in the open air. These cracks set up a great resistance to the passage of the current, and at these points become abnormally heated; hence the platina wire easily melts, whereas no such cracks are noticed when the wire has been operated upon in the vacuum and all its gases pumped out.

e is a cylinder, of lime, with a small spool on its extremity, on which the wire is coiled. About 30 feet of platinum or iridium wire coated with magnesia oxide is coiled upon the spool.

The wire may be of any size; but I prefer to use wire .005 of an inch in diameter, which will give a resistance when incandescent of about 750 ohms. By the use of such high resistant lamps I am enabled to place a great number in multiple arc without bringing the total resistance of all the lamps to such a low point as to require a large main conductor; but, on the contrary, I am enabled to use a main conductor of very moderate dimensions.

Another important point is gained by the use of lamps of high resistance, as the resistance of the wires leading from the main conductors may be of very moderate dimensions; hence can be placed in the pipes already used for gas, and at the same time effect a great saving in the cost of wire.

Still another point gained is, that the high resistance of the lamps allows all to be placed in multiple arc, which is the only method where the maximum economy is attainable, as the lamps, when connected to the circuit, draw from the central station just sufficient current to maintain it at the proper temperature, and if by accident or want of regularity in the main current the strength of the current should increase abnormally, the excess of heat sets the thermal regulator in motion and disconnects the lamp entirely from the circuit, thus stopping all further consumption of energy until the temperature of the lamp is reduced to its normal conditions. I will state that these changes are not perceptible to the eye; hence the lamp cannot consume any more energy than that required to cause it to emit a certain light.

No loss in economy occurs by using so large a resistance, because the loss of energy is proportionate to the radiating-surface exposed to the air and its temperature, and is independent of the resistance of the wire forming such surface.

m is a lime cup, into which the small end of the vacuum-burner is held. The platina wires pass under it to the binding-posts H K.

n is the thermal regulator, operated by the expansion of the air. When the temperature of the air between the bulbs becomes too great, the diaphragm bulges outward and the point *o* separates the spring *p* from R and disconnects the lamp from the circuit, where it remains until the temperature is reduced to the normal condition.

The spark upon the point is very small, as I employ constant field-magnets at the central station; hence the powerful sparks due to the secondary current set up by the weakening of the powerful field-magnet is avoided.

I will mention that the second globe, *c*, might be made entirely of glass, and the aneroid-diaphragm, provided with a platina tube, be sealed in the glass, or the aneroid itself be made of glass.

I am aware that an electric lamp has been made in which glass has been combined with other substances to form a case, and that efforts have been made to keep such case air-tight; but the changes of temperature have prevented the maintenance of a vacuum or the exclusion of the atmosphere. In my improvement the chamber containing the light is made entirely of glass, and I am able to obtain and maintain a vacuum, because there is no substance joined to the glass; hence the entire chamber can be hermetically sealed, and the conductors of metal passing through the glass and around which the glass is melted are so small as not to injure the glass by their expansion.

I am also aware that carbon has been heated in the presence of both liquid and gaseous materials for changing its character and adapting it to an electric light. In my present invention the gaseous materials contained in metallic wire are driven off by the action of heat evolved by an electric current while the wire is in a vacuum, so that the pores of the metal are not filled with any extraneous substance; but, on the contrary, the metal is solidified by the removal of extraneous matter and the pores closed.

In my application No. 166 I have set forth an electric lamp formed of pyro-insulated metal. I do not, therefore, claim the same herein.

I claim as my invention—

1. In an electric lamp, the combination, with a hermetically-sealed vacuum-chamber made entirely of glass of metallic conductors passing through the glass and around which the glass is melted, and an incandescent conductor placed in the electric circuit, substantially as set forth.

2. The method herein specified of treating metallic conductors for electric lamps, consisting in inclosing the conductor in a glass case, exhausting the atmosphere from such case, heating the conductor by an electric current, and then hermetically sealing such glass case, substantially as set forth.

3. The combination, in an electric lamp, of a hermetically-sealed vacuum-case made entirely of glass, conducting-wires passing through the glass and around which the glass is melted, and an incandescent body formed of a pyro-insulated wire and an infusible core for the same, substantially as set forth.

4. The combination of a transparent vacuum-case, a continuous conductor forming an electric candle, and a second transparent case forming a closed chamber, for the purpose set forth.

5. The combination of the conductor *d*, forming an electric candle, the transparent sealed case B, the transparent case C, inclosing the case B, and the thermostatic regulator *n o p* R, substantially as set forth.

Signed by me this 12th day of April, A. D. 1879.

Witnesses: THOMAS A. EDISON.
S. L. GRIFFIN,
EDWIN M. FOX.

The first and second claims of this patent are the only ones which are important to consider, the others being for obsolete details of construction.

The state of the art at the date when the application for this patent was made has an important bearing upon the question of its novelty. It will be necessary, therefore, to briefly review the results of some prior inventors in this line of work.

Perhaps the earliest mention of the incandescent electric light proper is in a paper by William Robert Grove, the inventor of the well-known Grove battery, in the *Philosophical Magazine*, third series, vol. xxvii., p. 442, from which the following is an extract:—

> The following was one of the apparatus which I used for this purpose, and by the light of which I have experimented and read for hours: A coil of platinum wire is attached to two copper wires, the lower parts of which, or those most distant from the platinum, are well varnished; these are fixed erect in a glass of distilled water, and another cylindrical glass over them, so that its open mouth rests on the bottom of the former glass; the projecting ends of the copper wires are connected with a voltaic battery (two or three pairs of the nitric acid combination), and the ignited wire now gives a steady light, or which continues without any alteration or inconvenience as long as the battery continues constant, the length of time being, of course, dependent upon the quantity of the electrolyte in the battery cells [vide Fig. 1].

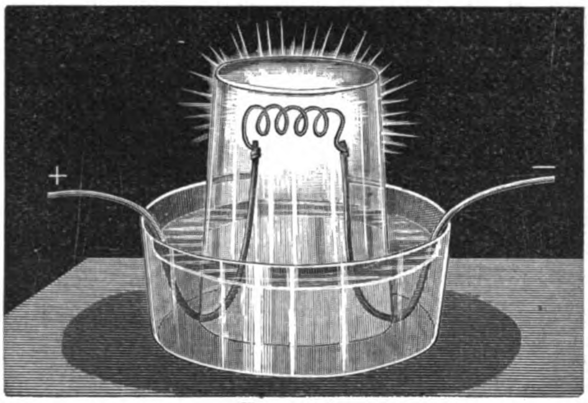

FIGURE 1.

According to the statement made in the paper, these experiments were made in 1840 and 1841, shortly after the invention of the nitric acid battery. The publication above quoted was made in 1845.

An American inventor named J. W. Starr, a resident of Cincinnati, devised, constructed and operated a lamp, which was patented in England, as a communication, by Edward A. King, November 4th, 1845 (No. 10,919), which was, in fact, a long step towards the realization of a practical incandescent lamp. Starr's lamp consisted of an air-tight glass tube, closed at its upper end, as shown in figure 2, and having one conducting wire hermetically sealed into the glass. A porcelain bar placed within the tube serves as a support for a slender carbon rod, the upper extremity of which is connected with the conducting wire at the top of the tube, and the lower extremity with the other.

The tube being filled with mercury and inverted, a Torricellian vacuum is formed above the mercury seal, so that

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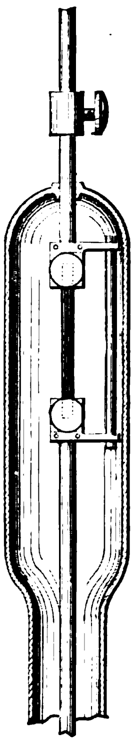

FIGURE 2.

the carbon when rendered incandescent by the passage of a current is entirely withdrawn from the influence of oxygen.

In 1847 Professor J. W. Draper, of New York, made a very interesting series of investigations on the heat and light evolved by platinum wires when traversed by powerful electric currents, and suggested that the currents might be regulated automatically.[3] The results described by Professor Draper some years afterwards attracted the attention of Professor Moses G. Farmer, then a resident of Salem, Mass., who was thereby led to attempt to make a practical application of Draper's results in an incandescent electric lighting system. Professor Farmer made a great number of experiments, relating not only to the construction of the lamp itself, but to the automatic control and regulation of the current. Among the substances tested for the purpose were aluminum, platinum, iridium, palladium, carbon, etc. Of all the metals, pure iridium was found to give the best results. The next best in order were alloys of iridium and platinum, and of platinum and palladium. Very satisfactory results were also obtained from carbon when enclosed in an atmosphere free from oxygen, as in the Starr lamp. In 1859, Professor Farmer constructed an apparatus for lighting the parlor of his house in Salem, which was actually used for that purpose every evening during the month of July of that year. This was probably the first instance in which a private dwelling house was ever lighted by electricity. The current was furnished by a Grove battery of six-gallon jars, 31 in number, placed in the cellar. Two incandescent lamps were placed in the parlor, one on each end of the mantelpiece, and these were connected to the battery in multiple arc. The switches for turning the lamps off and on were placed in a closet in another room. Figure 3 illustrates one of these lamps. It consists of a thin strip of platinum supported in metallic clamps formed of the blades of ordinary mechanical drawing-pens, to which the conducting wires were led through a hollow section of ornamental metallic gas-tubing, which formed a supporting standard of the lamp. The light emitted by each lamp was estimated to be equivalent to 32 candles. The results of this practical test showed that the incandescent light, although satisfactory in other respects, was much too costly for practical use, the expense being at least four times as much as that of an equal amount of light produced by gas.

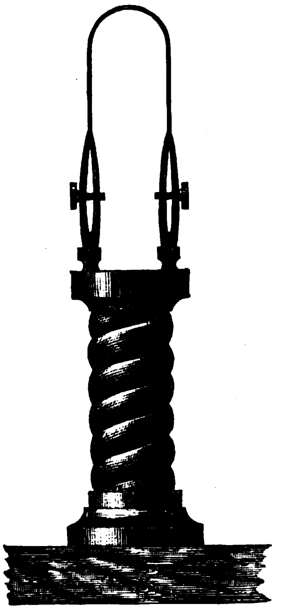

FIGURE 3.

In 1865, the thermo-electric battery, in which electricity is generated directly by the heat of coal or other combustible substance, was brought prominently into notice. In the hope that this invention might furnish a cheap source of electric energy, Professor Farmer again turned his attention to the problem of electric illumination. Between 1865 and 1868 he was almost constantly engaged in experimenting in incandescent lamps and electrical generators. During this time he had five such lamps connected in multiple arc. The electric current in the system was controlled by an automatic regulator, so sensitive as to be affected even upon the slight cooling of the lamps by a current of air produced upon the opening or shutting of a door of the room in which the apparatus was placed. This apparatus was on exhibition in Boston until 1868, when it was accidentally destroyed by fire. The form of lamp employed by Professor Farmer in most of these experiments is shown in figures 4 and 5.

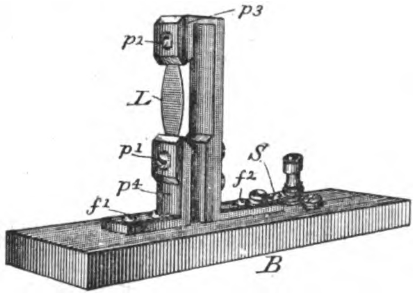

FIGURE 4.

FIGURE 5.

It is not necessary to more than mention the incandescent lamps of Lodyguine in 1873, and Konn and Kosloff in 1875, as these inventions, though not without interest, contributed little, if anything, towards the ultimate solution of the problem of incandescent electric lighting.

In 1877 and 1878, Mr. William Crookes, of the Royal Society, published an account of a remarkable series of experiments on radiant energy. Among the illustrative apparatus which he constructed and employed was a little instrument which he termed the radiometer, which may be briefly described as a small revolving wheel provided with vanes or paddles of mica, poised upon a delicate pivot within a highly exhausted and hermetically sealed glass bulb. Mr. Crookes showed that a paddle-wheel so constructed could be maintained in continuous revolution by the mechanical force of light alone. In an account of some of his experiments, published in London *Engineering*, April 19th, 1878, a description and illustration of one of these radiometers is given as follows:—

One of the instruments employed is that shown in fig. 6, in which is suspended in the ordinary way upon a needle point a four-armed radiometer, carrying rectangular vanes of clear mica, *b b*, set on an angle with the horizontal arms like the vanes of a smoke-jack. A short distance below this fly is fixed in a horizontal plane a circular loop of platinum wire, *c*, *c*, the two ends of which pass through the bulb, *being hermetically sealed into the glass*, and finish in the terminals + and —, by which the platinum ring can be placed in circuit with a voltaic battery, *and thus rendered incandescent.*

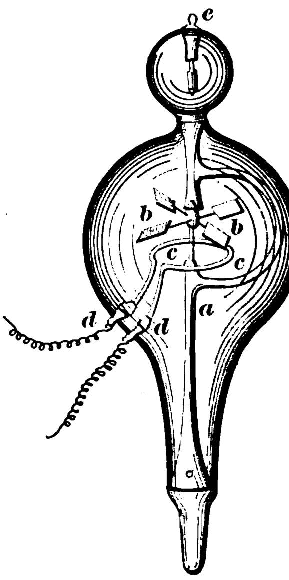

FIGURE 6.

For determining the pressure, the whole apparatus was connected by glass tubing and fused joints to a very perfect Sprengel mercury pump, designed and constructed by Mr. C. H. Gimingham, fitted with apparatus for obtaining a chemical vacuum by different absorptions of different substances contained in the residue gases, as well as for eliminating from the same all traces of aqueous vapor, and having attached to it McLeod and barometric gauges for measuring the pressure at different degrees of exhaustion. For the observation of the appearance of the electric discharge—a very valuable indication of the progress of the exhaustion—there was attached to the apparatus a vacuum tube in gaseous connection with its interior, and in which two platinum electrodes were placed very close together. In addition to these accessories, there was a small torsion balance carrying at one end a standard disc of blackened mica, and at its centre a small mir-

3. *Silliman's Journal* (2d Series) lv., 1847. Phil. Mag., May, 1847.

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ror, by which its angular displacement could be measured by the movement of a spot of light along a scale, and lastly, there was the special apparatus, which has been described, containing the rotating disc and vanes, and the platinum ring which, by being put into and out of circuit by a Morse key with a voltaic battery, through various resistances could be rendered either just warm or heated through various degrees of incandescence almost up to its temperature of fusion ; and when it is remembered that provision had to be made for the introduction of various gases into the apparatus previous to the process of exhaustion, it will be readily understood that, although the whole arrangement was as simple as its requirements would admit, still it was considerably elaborate ; from its necessary complexity, it required the utmost skill to construct, and it was impossible to be carried about.

In order to show the phenomena which have been described to the members of the Royal Society, in illustration of his paper, Mr. Crookes had several instruments identical in construction to that represented in figure 6, but containing gaseous vacua of different degrees of exhaustion, one being at atmospheric pressure, and the others at the pressures at which the more remarkable effects are observed, and to which we have referred. The effects, which were very interesting, were made apparent to the audience by an image of the instrument under experiment being projected upon a screen by means of a sciopticon lantern.

The influence of the residual gas upon the radiation of heat was beautifully illustrated in these experiments by the greater or less degree of incandescence of the platinum ring with the same battery power at different degrees of exhaustion of the gas surrounding it. The same battery power which would almost fuse the wire in the bulb at higher degrees of exhaustion was capable of only just reddening it at atmospheric pressure, so that, in order to obtain the same temperature of the platinum wire in vacua of different degrees of attenuation, it is necessary to vary the battery power, or what produces the same result, to interpose in the circuit greater resistance as the vacuum becomes more perfect. The comparative temperatures of the rings at different exhaustions were very remarkably illustrated when three instruments, differently exhausted, were joined up in the same circuit, so that the electric current had absolutely the same strength in each case. When this was done the ring in the normal atmospheric pressure was black, that at a higher exhaustion was just red, *while the coil in the still more attenuated medium glowed with incandescence like a small electric lamp.*

Several of these bulbs, sealed up at different degrees of exhaustion, were exhibited at a soiree of the Royal Society, on the evening of April 5, 1876, by Mr. Crookes, and attracted much attention.

A comparison of this apparatus with that shown in the drawings of Edison's patent, especially in view of the prior researches of Grove, Draper, Starr, and Farmer, will enable any person to judge for himself of the degree of essential novelty which is exhibited in the device on which Edison's claims are founded.

UNITED STATES PATENT OFFICE.

Thomas A. Edison, of Menlo Park, New Jersey.

ELECTRIC LAMP.

Specification forming part of Letters Patent No. 223,898, dated January 27, 1880. Application filed November 4, 1879.

To all whom it may concern:

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, have invented an Improvement in Electric Lamps, and in the method of manufacturing the same (Case No. 186), of which the following is a specification.

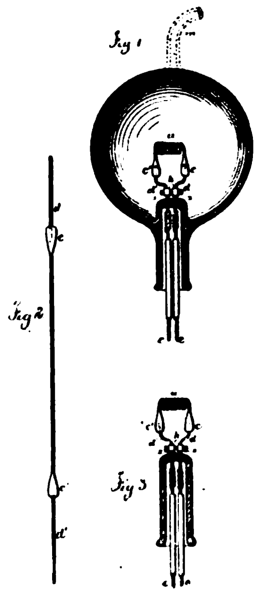
The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light. The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum-bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading-wires and the carbon conductor

Heretofore light by incandescence has been obtained from rods of carbon of 1 to 4 ohms resistance, placed in closed vessels, in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading-wires and the carbon has been obtained by clamping the carbon to the metal. The leading-wires have always been large, so that their resistance shall be many times less than the burner, and, in general, the attempts of previous persons have been to reduce the resistance of the carbon rod. The disadvantages of following this practice are, that a lamp having but 1 to 4 ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions; that, owing to the low resistance of the lamp, the leading-wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented; hence the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly coherent highly-heated surface of the carbon. I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating-surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar, its resistance may be made high or low, according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a closed crucible for several hours and afterward moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seventy-one thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.



All these forms are fragile and cannot be clamped to the leading-wires with sufficient force to insure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be molded around it in the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps; hence the burner and the leading-wires are connected to the carbon ready to be placed in the vacuum-bulb.

When fibrous material is used the plastic lamp-black and tar are used to secure it to the platina before carbonizing.

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading-wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum-bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

By using a considerable length of carbon wire and coiling it, the exterior, which is only a small portion of its entire surface will form the principal radiating-surface; hence I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show.

I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp-black, plumbago, and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters. Each wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization it is to be coiled between a helix of copper wire. The ends of the carbon or filament are secured to the platina leading-wires by plastic carbonizable material, and the whole placed in the

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carbonizing-chamber. The copper, which has served to prevent distortion of the carbon thread, is afterward eaten away by nitric acid, and the spiral soaked in water, and then dried and placed on the glass holder, and a glass bulb blown over the whole, with a leading-tube for exhaustion by a mercury-pump. This tube, when a high vacuum has been reached, is hermetically sealed.

With substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting non-carbonizable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

In the drawings, figure 1 shows the lamp sectionally, *a* is the carbon spiral or thread. *c c'* the thickened ends of the spiral, formed of the plastic compound of lamp-black and tar. *d d'* are the platina wires. *h h* are the clamps, which serve to connect the platina wires, cemented in the carbon, with the leading-wires *x x*, sealed in the glass vacuum-bulb. *e e* are copper wires, connected just outside the bulb to the wires *x x*. *m* is the tube (shown by dotted lines) leading to the vacuum-pump, which, after exhaustion, is hermetically sealed and the surplus removed.

Figure 2 represents the plastic material before being wound into a spiral.

Figure 3 shows the spiral after carbonization, ready to have a bulb blown over it

I claim as my invention—

1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth.

3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

4. The method herein described of securing the platina contact-wires to the carbon filament and carbonizing of the whole in a close chamber, substantially as set forth.

Signed by me this 1st day of November, A. D. 1879.

Witnesses: THOMAS A. EDISON.
S. L. GRIFFIN,
JOHN F. RANDOLPH.

The important claims of the above patent are the first and second, the others being merely for special details and methods of construction. The application was filed November 4, 1879. Another and subsequent application was filed by Edison on December 11, 1879, one claim of which was for "the incandescent conductor for an electric lamp formed of carbonized paper." On January 9, a little less than a month afterwards, a joint application for a patent for electric lighting was filed by Messrs. W. E. Sawyer and A. Man, claiming, among other things, substantially the same invention. These two applications were put in interference by the Commissioner of Patents; a large amount of testimony was taken on both sides, and the Examiner of Interferences decided Sawyer and Man to be the prior inventors of the contested subject-matter. This decision was reversed by the Board of Examiners-in-Chief, but was appealed to the Commissioner of Patents in person, who rendered a decision October 8, 1883, affirming the decision of the Examiner of Interferences, and awarding priority to Sawyer and Man.[4] After several attempts to obtain a reopening and rehearing of the case on its merits, the original decision was reaffirmed by Commissioner Butterworth, and a patent for the invention of Sawyer and Man was issued on May 12, 1885.[5] The testimony taken in the interference proceedings shows that Edison did not make the invention described in patent No. 223,898 until October, 1879, while Sawyer and Man commenced their experiments in electric lighting in February, 1878; they had the invention in a rude form as early as March, 1878, and in a complete and operative form in September or October, 1878; thus anticipating the completion of Edison's invention by nearly a year. The testimony showed that Sawyer and Man at this date had lamps in operation that lasted for hours, and even days, consisting of an illuminating chamber made entirely of glass, and hermetically sealed, and from which the air had been exhausted, and having metallic circuit-conductors passing through the glass walls of the chamber, and hermetically sealed therein, and an illuminating or incandescent conductor included in a circuit within said chamber, in the form of an arc or loop made from carbonized fibre or textile material.

It will be seen that the invention set forth in the first claim of Edison's patent, in so far as it differs from the prior invention of Sawyer and Man, differs only in the form and dimensions of the parts. A "filament" of carbon differs from a "strip" of carbon, as used by Sawyer and Man, only in that the former is longer and thinner; so also Edison's metallic wires, to which the carbon is secured, differ from those of Sawyer and Man only in being of less thickness. These differences, it is true, are in practice of the utmost importance, as they enormously increase the commercial efficiency of the lamp, but it may well be doubted whether any exercise of the faculty of invention is required to pass from one to the other. It could certainly have required no invention, in the state of the art in 1879, to know that the resistance of the paper carbon could be largely increased by making it long and thin—that is to say, in the form of a filament—and it certainly cannot be patentable *per se* to make a filament of great resistance which had heretofore been made of small resistance, if for no other reason, because the term "high resistance" in the specification has no determinate meaning. Edison's specification states that lamps not exceeding four ohms resistance are of "low resistance," but how much this figure must be increased to render them of high resistance we are not informed. This claim, therefore, so far as it depends upon the high resistance feature, would appear to be void for uncertainty.

Precisely the same reasoning applies to the subject-matter of the second claim. The invention claimed is distinguishable from the anterior one of Sawyer and Man only by the use of the term "filament." If the carbonized paper strip of Sawyer and Man be increased in length and diminished in cross-section, by what criterion is it to be determined when it ceases to be a "strip" and becomes a "filament?"

It is difficult to understand why the application for this patent was not also included in the interference to which we have referred, for it seems certain that, so far as the invention or the subject-matter of the patent is embodied in the first two claims, it is not distinguishable from that of Sawyer and Man, which was filed a year in advance of it. No one can question that the Edison lamp is both mechanically and commercially a vast improvement over its predecessor; but it is no less true that the features which constitute it such an improvement appear to be precisely the ones which the patentee has omitted to claim.

UNITED STATES PATENT OFFICE.

Thomas A. Edison, of Menlo Park, New Jersey, Assignor to the Edison Electric Light Company, of New York, N. Y.

METHOD OF TREATING CARBONS FOR ELECTRIC LAMPS.

Specification forming part of Letters Patent No. 265,777, dated October 10, 1882.

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful method of treating carbons for electric lamps (Case No. 275); and I do hereby declare that the following is a full and exact description of the same.

In the manufacture of my incandescing electric lamps, having for the continuous incandescing conductor a flexible carbon filament of high resistance, I have found that there is a considerable quantity of air, gas, and aqueous vapor occluded in the carbon filament and the clamps, which are not removed from the lamp by the action of the pump, but have to be driven off by raising the carbon filament to incandescence by the passage of an electric current therethrough.

In patent No. 227,229, granted to me May 4, 1880, the method is described of driving the air from a metallic incandescing conductor by the heat of the conductor when raised to incandescence by the passage of an electric current therethrough. In applying this method to a carbon filament, however, some changes have to be made, occasioned by the increased quantity of air, gas, and aqueous vapor occluded by the carbon filament, and also by the fact that the air has to be driven from the enlarged ends of the filament and from the metal clamps wholly by conduction of heat from the incandescent body of the filament.

4. The decision in full may be found in 25 Off. Gaz., 597.

5. For copy of this patent, see ELECTRICIAN AND ELECTRICAL ENGINEER, p. 233, this volume.

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these changes in the method consist principally in maintaining the incandescence of the carbon filament for a longer period than with a metallic incandescing conductor, and in raising the carbon filament gradually to a higher degree of incandescence than with the metallic conductor. With the carbon filament the incandescence finally produced in the process of exhaustion is always higher than the degree of incandescence to which the filament will be raised in use. With the carbon filament (in this respect differing from the metallic conductor) it is desirable that greater flexibility should be given the filament than it would have if the lamp were exhausted simply by the action of the pump, so that the carbon filament can withstand, without fracture, the jars to which it will be subjected in handling and transportation previous to the use of the lamp. This additional flexibility is given the carbon filament by the passage of an electric current therethrough, the operation being simultaneous with that of driving out the occluded air, gas, and aqueous vapor. It is also desirable to fix the shape of the carbon filament during the manufacture of the lamp, so that the character of the lamp can be determined, since some of the filaments are warped or bent more or less to one side or the other when raised to incandescence; but by raising the carbon filament to higher incandescence than that to which it will be raised in use the shape of the filament will be fixed and determined, and will not be changed by the future use of the lamp. This operation, which is peculiar to the carbon-filament operation, is also simultaneous with that of driving out the occluded air, gas, and aqueous vapor.

In carrying out the invention the parts of the lamp are assembled and united as described in my application No. 22,301, of even date with this application, or in any other suitable manner. The lamp is then attached to the exhausting apparatus (a Sprengel drop-pump), and when the proper high degree of exhaustion has been obtained an electric current is passed through the lamp, and by cutting resistance out of circuit the filament is gradually raised in incandescence. The filament is kept for some time at a medium incandescence, the operation of the exhausting apparatus being meanwhile continued. The filament is then raised to a much higher incandescence by the cutting out of more resistance, until the air and gas and aqueous vapor have been driven from the enlarged ends of the filament and the clamps, which can be readily determined by the disappearance of a blue or violet color which is seen at the clamps while the gas and vapor are being driven off. This high incandescence is considerably higher than that at which the lamp is designed to be used, it being from 30 candle-power upward in a lamp designed to give 16 candle-power.

What I claim is—

1. The method of treating the carbon filament of an incandescing electric lamp, consisting in raising such carbon filament to incandescence during the latter part of the process of exhausting the lamp-globe, whereby the air and gas are driven from the carbon filament and the flexibility of the filament is increased, substantially as set forth.

2. The method of treating the carbon filament of an incandescing electric lamp, consisting in raising such carbon filament to a higher incandescence than that at which it is designed to be used during the latter part of the process of exhausting the lamp-globe, whereby the air and gas are driven from the carbon filament and from its enlarged ends and clamps, and the flexibility of such filament is increased and its shape fixed, substantially as set forth.

This specification signed and witnessed this 11th day of December, 1880.

Witnesses: THOMAS A. EDISON.

H. W. SEELY,
WM. CARMAN.

It will be observed that the subject of the first claim is a method of treating the carbon filament of an incandescent electric lamp. This "method" is in reality precisely the same as that already described in Edison's prior patent 227,229, quoted above, as well as in the extract describing the experiments of Professor Crookes, and differs only in respect to the material to which the treatment is applied. An attempt has been made in the specification without much success, to draw a distinction between the two methods, the main point insisted upon being that the carbon filament is to be raised during treatment to a higher incandescence than that at which it is designed to be used. This would seem to be a somewhat slender distinction on which to base a patent. Suppose another party makes use of the process, and in treating the filaments makes use of a current of precisely 1 ampère and no more, labels his lamps accordingly, and then says to the consumer: "These lamps are designed to be run with a current of 1 ampère, but we advise you to use a current of not more than $\frac{95}{100}$ of an ampère, and then your lamps will last so much the longer." Is the patent infringed or not?

A particular process which has been used in a certain manner for a certain purpose, namely, to drive out the occluded gases contained in an incandescent conductor of metal, does not become a new process when applied in the same manner to drive out the occluded gases from a metalloid. How can it be anything more than a double use of the old process? The old process having, moreover, been described in a patent issued several months before the application for the present patent was filed, to say nothing of the description of Crookes's experiment, cannot legally be repatented under a second application. There is much reason, therefore, to anticipate that the result of the litigation which has been commenced by the Edison Electric Light Co. will rather tend to disestablish than to establish their patents, and it seems extremely probable that the ultimate conclusion of the litigation will be to throw open to the public a number of the most important inventions and processes having to do with incandescent electric lighting.

IMPROVED SECONDARY BATTERY.

At a recent meeting of the Berlin Physical Society, Dr. Kalischer described a new secondary battery, intended to overcome the disadvantages of the usual accumulators—namely, that the sheet of lead used as anode was very soon destroyed. This object he is said to have attained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron, on being immersed in the solution of lead, became passive, and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm coherent mass, enveloping and protecting the iron on all sides. The charge was continued till the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of the charge all development of gas must be avoided as otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As cathode a sheet of lead was used, but it was attended by two disadvantages. In the first place the lead, during the charge, separated itself at the cathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current). In the second place the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamizing the cathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamized lead, yielded, after the electric charge, which could be carried out without any special preparations, a current of about two volts; after about six hours' discharge, however, the electromotive force sank to 1.7 volts, but, on the battery being left to itself for 24 hours, it became a little increased. According to the measurements hitherto taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.

MEASURING THE CANDLE-POWER OF A LIGHT.

The candle-power of a light may be approximately calculated by comparing the shadow cast by a rod in the light of a standard candle with the shadow cast by the light to be tested. By moving the latter toward or away from the rod a point will be reached at which the shadow cast by both lights will be of the same intensity. The intensities of the two lights are directly proportional to the squares of their distances from the shadows, *i. e.*, suppose the light to be tested is three times the distance of the candle, its illuminating power is nine times as great.

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THE DISTRIBUTION OF ELECTRICITY.[1]

In the last lecture I was engaged in describing the different methods which have been used to apply what is called the multiple arc system of electric lighting. The multiple arc system is a system in which there are one positive and one negative lead between which the lamps are placed. I think that we succeeded in arriving at several very general conclusions which simplify the consideration of the manner of laying mains a great deal. I think I am right in saying that in the past the practice of designing mains has been to a certain extent haphazard; the mains have been selected a little at random, and then, perhaps, afterwards adjusted to a slight extent; but there has not been that thorough calculation and estimating of the effects which could be done by calculation, and in consequence of that there have been some grievous failures in electric lighting on the multiple arc system. I think we arrived at one or two important generalizations which must be accepted as necessary for economy, and in such a system—the multiple arc system—the amount of copper used in our mains is so enormous that every one must admit that economy is the first consideration, and that all engineering difficulties that there may be must be met by the engineer as difficulties which can be conquered. The most important results which we have arrived at were, I think, pretty clearly shown by illustration by this diagram of the city of Chicago, as we chose to call it, in which it was shown that, in order to have good distribution, there must be no great variation of pressure in the mains, electric pressure in the mains corresponding, as you will remember, exactly with hydraulic pressure if it were a service of water; and in order to prevent our having too great a variation of pressure in different parts of the district, or in the same district at different periods of the night, when the consumption over the district varies, it is necessary, as I showed by means of this diagram, to have a large number of distributing boxes with figure mains, trunk lines of conductors coming to these distributing boxes and feeding them, and each one of these distributing boxes then serving to light up a certain space, which in this diagram is essentially a triangular space. And I also gave you the rules for determining what is the size of the district which may be lighted up by such a distributing box, and I think every one here will agree with me that the limit was very confined indeed compared with the general ideas which prevailed as to the number of distributing boxes which are required; that is to say, that, upon the assumption upon which we have been going of the size of conductor required to carry a certain current, we concluded it would be necessary to have the distributing boxes so close that no lamp should be at a greater distance than 124 yards from the distributing box. Another important point which has been, I think I may safely say, altogether neglected in all schemes which have been hitherto issued for distribution of electricity from central stations is this: that the distributing box, the point from which the distribution takes place, must be closer to the central station than any of the lamps which are fed by that distributing box. As a general rule, the distributing box has been put in the centre district which it feeds, and that is a mistake; it ought to be nearer the central station than any of the lamps which it feeds. I gave you also in the last lecture some account of the relative cost of different systems of lighting in the multiple arc way, and it was found that, by introducing a large number of distributing boxes in this way, the cost was very materially reduced; but, at the same time, the cost was very great even with these distributing boxes. And the cost may be divided into two parts: first, the cost of the supply wires, the conductors which are supplying the electricity from each distributing box to the houses, which are represented by the square lines round each block of buildings there (fig. 1, p. 222); and secondly, there is the expense of the feeders, the conductors going up to the distributing boxes. Now when we increase the size of our district to any considerable extent, the cost of these feeders, these trunks which carry the electricity to the distributing boxes, is far greater than the cost of the supply system of conductors. If there be a means of reducing the cost in this way, that is to say, any way of cutting out these feeding conductors, that will be a very great economy indeed.

SMALLER CONDUCTORS AND HIGHER POTENTIAL.

This evening I will leave altogether apart the system of multiple arc lighting, which is the system which has been almost universally adopted in the past, and I shall speak this evening about the different systems which have been proposed and partly carried into effect for using higher pressure in the mains. The work which is done by a certain number of lamps is a perfectly definite amount of work, and it is measured by the product of the pressure of the electricity—the product of the quantity of the electricity which flows. If we increase the pressure, we diminish the quantity of electricity that flows; that is to say, we diminish the current; and if we diminish the current, we can diminish the size of our conductors.

Now a great deal has been talked about the danger of introducing high pressures in electric distribution. I think that I shall find general agreement among competent people when I say that a great deal of what has been talked in this way is pure nonsense, and that high pressures are not in the least more dangerous than our present systems of illumination; that if we have to bring high pressures of electricity through a district, those pressures are confined to the wires, and it is only in the case where there is disgraceful negligence of duty, and a disgraceful leakage towards the earth in some part of the system, that it is possible for anybody to receive a dangerous shock from the wires of such a system. The wires which conduct the electricity into a house of any of these high potential schemes can never have a greater difference of pressure between them than what is required for the lamp; that is, in the present state of affairs, something like 100 volts. We will say that is the highest pressure there can exist between the two wires, and it seems almost incredible that there should ever be allowed to be a leak in the system so great that when a person touches one of the wires he should have a high current flowing through his person which would be dangerous. If we are to abolish the idea of using high potentials simply because of this vague notion that some time a shock might be experienced, we might as well abolish the whole system of gas lighting, because it is possible that people can go into rooms where there is a leakage of gas with a lighted candle. The danger from gas is infinitely greater than that which can ever come from high potential electricity, and the difficulty of detecting a leakage of gas is likewise infinitely greater than the difficulty of detecting a leakage of electricity. A properly organized system of distribution of electricity at high potential would render a severe shock to any person absolutely impossible, and that is the point which needs to be dwelt on very strongly at present, because so much has been talked, and so much nonsense has been talked, about the dangers of high potentials.

I have often found a great convenience in describing the effects of electricity and the systems of distribution by reverting to the analogy of water pressure, and, I think, those of you here who are not deeply conversant with the subject of electrical engineering will, perhaps, be assisted by a few words of reference to the analogy of water pressures. At present we see through different parts of London pipes being laid for supplying power by means of water at high pressure. This water is utilized in motors or turbines, through which the water passes. The water pressure is remarkably analogous to the pressure of the electricity in our mains; the turbines or other motors which

1. Cantor Lecture, delivered at the Society of Arts, by Professor George Forbes, February 16, 1885.

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are used to develop the power have remarkable analogy to the incandescent lamps or the arc lamps, or the electric motors which may be used with a system of distribution. Now, in the manner of laying pipes which we have all observed in the streets of London, all these turbines or water engines are connected directly on to the same set of pipes; in other words, they are all connected in multiple arc, as we would say in electric language. But it would be quite possible to conceive of two turbines connected together in series; that is to say, with a very high pressure in the mains first driving through one of these turbines, and then the outflow of water from that turbine still admitting of considerable high pressure to second turbine, which it should work with the superabundant pressure which should exist. This is exactly analogous also to the electric system of distribution in series; and this will be clear by examination of this diagram, fig. 1, the dynamo machine

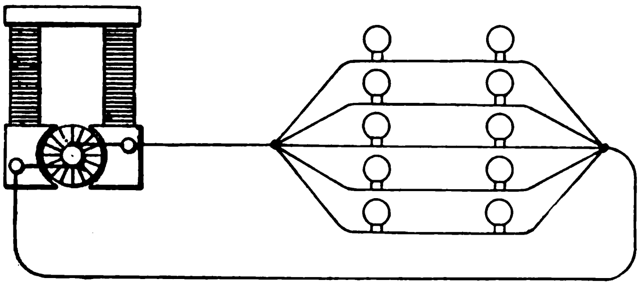

FIGURE 1.

with the two leads coming from it, and here are a number of circuits, each circuit having two lamps in series. This is exactly equivalent to a main to come along here, split into a number of water pipes with two turbines put in series. It follows that the pressure of water required to drive these two turbines is double the pressure required to drive the one. So it is exactly the same in electric distribution. We simply have to increase the pressure when we put a large number of lamps in series.

THE USE OF SECONDARY BATTERIES.

Now, there are several different ways in which high potentials can be used effectively and with economy. I will begin with mentioning the probable future which there may be in the application of secondary batteries. We often hear it remarked that the present systems of electric distribution are weak in some points, and that if only a system of secondary batteries were introduced, everything would be clear, and there is no doubt that, by introducing secondary batteries, a great deal of facility is given to the scheme. In the first place, you can have a much smaller engine power, much smaller dynamo power, because your dynamos can be working the whole day charging these accumulators, and only used for supply when it is required. In the second place, you can put your secondary batteries all in series over a large district, and charge them up all in series, and then discharge them each to its local district, a small number at a time, and a small number at one place. In this way, by using high potentials, of course we should use small currents. In the hydraulic analogy, by using high pressures, we require a smaller volume to flow, and therefore we should require smaller conductors, and consequently there would be a saving in laying down our copper. This is perfectly true, and there is not the slightest doubt a secondary battery system is of the utmost value, and would help us enormously. But at the present moment there are several difficulties in the way of introducing secondary batteries like this; and the first is, perhaps, the most fatal one, and that is, that we have no secondary battery. I do not mean to say that a great deal has not been done in the last four years in improving secondary batteries; it is my firm belief that a very great deal has been done even in the course of the last year in improving secondary batteries; but at the present time we have not sufficient confidence in the action of secondary batteries to justify any engineer in depending upon them in designing a scheme of distribution. But I must say that there is a great probability of something being done in this direction, because there is such a vast amount of intellect in the whole world being devoted to this particular line, trying to perfect it; and already I have seen such enormous improvements in secondary batteries of late that I cannot help thinking that very likely soon we shall arrive at something much more near perfection; and for this very reason I consider it is of the utmost importance that engineers should consider all such schemes which enable them to use high potentials, because, even though at the present time such a scheme as that introduced is imperfect to a certain extent, those schemes which lay down small wires for using with high potentials are the very schemes which will become applicable when the secondary battery is really a commercial thing in our possession; and, therefore, any person who has at the present moment to lay down a large system of lighting with the multiple arc system would perhaps find in the course of a year or two that the whole of this enormous cost of copper he had laid down would be utterly wasted, because some discovery which had been made would enable him to use smaller conductors. For this reason I consider, in designing a scheme of electrical distribution, an engineer should consider the great importance of a probable discovery in the way of secondary batteries.

There has been one large experiment in the way of secondary batteries made at Colchester, and I have got diagrams here showing schemes of electrical distribution. With respect to the diagram at the other end of the room, which was referred to in the first lecture (fig. 1, p. 182), I would simply say, if you have troughs, or good-sized channels in which your conductors are laid, there is very little difficulty about your insulation; with a good branch system and plenty of room the engineering difficulties are comparatively trivial, as long as you will remember the facts which I pointed out in my first lecture, that you are not to trust to your insulating material as the support for the conductor. Your conductor must be supported by a substance capable of supporting it, not by a bituminous compound through which the conductor will sink in the course of ages. But there are no engineering difficulties if you are able to have a trough for conducting your wires, and I am perfectly of opinion that if you have the mains laid down in that way, you can use your 5,000 volts with perfect facility, and there will be no danger, and with proper tests regularly made, such a system would not only be possible, but perfectly safe. With respect to this long diagram, fig. 2—rocking switch, it shows the arrangements which are made at Colchester by the South Eastern Brush Co. for distributing their electricity. The dynamos with the charging mains act through what is called a rocking switch into the secondary batteries. Now, in this supply system, first we have charging mains coming to the secondary batteries situated in different districts through the town, and then from the secondary batteries we have service mains going away to different houses which are to be supplied, and this rocking switch is controlled by what is called the master cell, which is simply a cell with a diaphragm, so that when the ebullition of gas becomes too great, the diaphragm is raised, and the contact is made, which switches over this rocking switch, and the cells then being considered to be thoroughly charged, are transferred from the charging system of mains to the service system of mains. That is the arrangement which was adopted there. One of these cells which are used there is shown here, one of the Consolidated company's cells, which I have lately had the opportunity of testing very carefully, and which seems to give fair results; and I have upon the table below two plates, a positive and a negative plate, and you can examine them and see how they are constructed. Let

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me put in a word here in parenthesis. I do hope that those who are electricians will not allow the term negative to be applied to what ought to be positive, and the term positive to what ought to be negative. I cannot understand why, since secondary batteries have been introduced, the whole language which electricians have been accustomed and got habituated to should be utterly reversed, and if certain companies, who make these batteries persist in calling the plates in that way, I dont see why electricians should adopt them, and why they should not stick to the terms they have been accustomed to use. I only hope a word put in in season here and there will lead to electricians insisting on proper terms being given to these plates. Here also I have some plates well worthy of examination, kindly lent me by the Electrical Power Storage Co. I may say that I had the good fortune to look through the work they have been doing of late, and I have been very much struck by the enormous progress they seem to have made in the practice of the construction of cells and the maintenance of them in good order and the prevention of the sulphating of these plates, which has been a source of very great trouble; and one of the chief things I was shown was the way in which these negative plates are kept in good condition, and how it is impossible to injure them, apparently, by over-charging. I believe I am right in pointing to this one (indicating a cell on the table) as one which has been persistently over-charged with the idea of trying to damage it, trying to make it worse, and if you look at it you will see as good a plate as you ever saw in your life in any secondary battery, the material perfectly sound and excellent. It really seems to show that one of the chief difficulties that has been met with is charging with too weak a current, and allowing the battery to degenerate, and not keeping it thoroughly charged up.

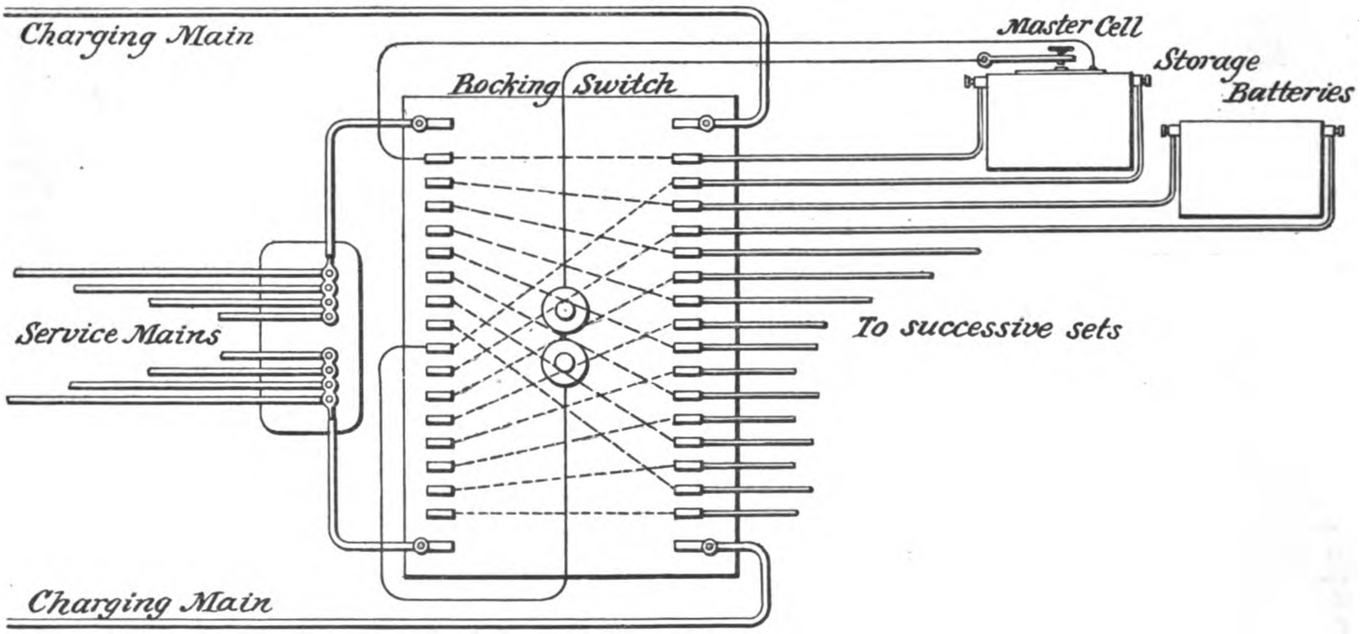

FIGURE 2.

SECONDARY INDUCTION CURRENTS.

Next, I wish to draw your attention to a system of supply with high potentials which has been introduced by means of secondary induction currents. It is a very old idea, indeed, to use induction currents in order to use a high potential current in the mains, and a low potential current in the supply service. I believe that the first patent which I have come across which was taken out in connection with this was by Mr. Harrison, in the year 1857, and since then it has been patented over and over again, and here is a general idea of it shown in this diagram, fig. 3, where there are supposed to be rods of iron (indicating) surrounded by coils of the main wire; here is the main wire coiling around one end of these iron bars. The lamps, then, are connected, their terminals, by a wire which coils around the iron bar also, an alternate current is used to pass through these main coils, and it sets up alternate magnetization in opposite directions by these iron bars, and the magnetization induces electric currents in this wire which is connected with the lamp, and consequently we are able to magnetize this bar by the main wires with any potential that we please, and we are able to draw off by these induced currents a current of any potential that we please. In this way different lamps in different parts of the circuit can be fed with a current of whatever pressure you please, although the main exciting current is of very high pressure, indeed; but, mark this, there is absolutely no danger in this system, because the charging current is in a closed circuit which never goes near the rooms where the lamps are actually at work; a lamp thus never has over the potential which is required for that lamp, and the high pressures which are used in the mains are confined simply to a closed circuit of wire; therefore there is absolutely no danger in such a system. I have said that this is a very old system. The idea is very old; but it is only in the last few years that it has been worked out practically and with confidence, with a confidence that does honor to M. Gaulard, I may say, for the way in which he has attacked the problem; he was confident from the very first. I think it was three or four years ago when we first saw his apparatus in the Westminster Aquarium; since then he has been improving it, and has brought it to a practical issue. Since then I have not myself had the opportunity of experimenting upon those apparatus; but I simply draw my conclusions from the reports, in the first place, made by Dr. Hopkinson and others; and I have not the slightest doubt that from these secondary generators it is possible to get a return of 90 per cent. in the lamp circuits. This is a result which is very remarkable, and is worthy of far more serious consideration than it has received up to the present time from most people, though, of course, many advanced electricians have been looking with eager interest at the result of these experiments. During the course of the last summer experiments were being made, as most of you are aware, at the electrical exhibition at Turin, and I have here a plan of the scheme which was used there, and of the way in which the wires were

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used. Altogether the circuit had a length of about 50 miles; and we have evidence of the large number of different kinds of lamps used upon that circuit—a large number of Bernstein, Swan, Siemens, and Edison lamps—a large number of different lamps of different pressures, all worked from that central station over that great distance, so that the matter of distance is apparently overcome; these distances were, of course, much greater than they would be in any town distribution. I don't think I will say anything more about the system just now, except this: that if there is no difficulty about the expense of it, it is well worthy of far more attention than has been given to it up to the present. I had the pleasure of looking at the installation which is being commenced at the Grosvenor gallery the other day, and I see there is no doubt we shall have an opportunity very soon of seeing a very large installation there, and at the Inventions exhibition there is going to be a considerable amount of work done by the same system. After those two experiments we shall be in a position to judge whether, economically, it is good. In every other point, except, perhaps, the induced currents which the alternate current machines may create in telegraph wires and other circuits, there really seems to be no objection to the system. It is true there is a great objection to alternate current machines, but when we come to examine it there is very little to be argued against it; if the leading and return wires are brought very close to-

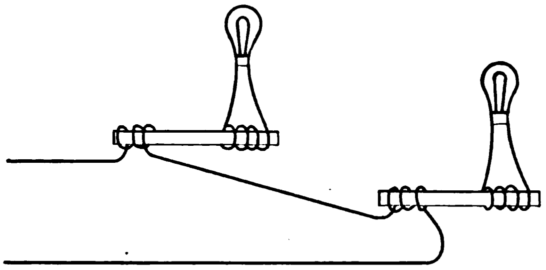

FIGURE 3.

gether, induction in neighboring telegraph wires is small, and I really think that we ought to look—all electrical engineers ought to look—very closely into these experiments which are being made just now, for it really promises well.

THE MULTIPLE SERIES SYSTEM.

Now let us go on to the other systems, and which are more analogous to those which we have been describing previously; and, first, let us speak of the multiple series system. Here is a system, which I have alluded to, of multiple series on which there are two lamps on every series, fig. 1. Now the trouble of that was, when it was first introduced, that if one of those lamps went out, the other in the series went out. In order to prevent that, it was suggested to bring a wire connecting the intermediate position to all the lamps in the circuit. Then if one goes out, the other does not, because it is fed by the current coming from the other lamps. Another example shows it in a different manner. There we go through successive pairs of lamps, the pressure gradually falling as we go along, and pass through the nine different series connected up. I do not know when this system was first proposed; it is very old, I believe. The first time that it was practically seen in action was, I believe, at the Paris exhibition of 1881, when Mr. Edmunds lighted the Congress Salon by Swan lamps, the lamps all being fitted in multiple series in this manner. After that the most important experiments made were those by Mr. Preece at Wimbledon last year, when, in some experiments he made for the commissioners of sewers, he lighted up a large part of Wimbledon with incandescent lamps, all on the multiple series system; and quite lately we have had brought before our notice by Mr. Kierzkowski-Steuart an admirable account of the lighting of Temesvar, in Hungary, by means of a multiple series system like this, in a very remarkable article which appeared in a recent number of *Engineering*, giving a detailed description of the arrangements there, which had, undoubtedly, been worked out with very great care before laying down the installation. Now, the multiple series system is one which is admirably adapted to certain cases; it is admirably adapted to Temesvar, in Hungary, because it is only used there for street lighting, and the lights are always all required at the same time. But it is not suitable for house-to-house distribution, simply for the reason that, if some of the lamps are put out, then the other lamps on the circuit have too much current. Having shown by experiment how this would act, the lecturer proceeded: Now that would be intolerable in a general supply of electricity; that when one house in a block of buildings was using rather less current than usual, other persons in that block should get far too much current, would be intolerable, and that the next block of houses should receive so little current as was shown by these lamps (in the experiment) would also be intolerable. Various devices have been proposed for getting over these difficulties. I will deal with one or two. The first system which I shall speak of is one which has already been put into practice, and it is undoubtedly a most ingenious principle. That is what is called the three-wire system, which Dr. Hopkinson originated. (See page 102, March, 1885, ELECTRICIAN AND ELECTRICAL ENGINEER.) There we have two dynamos at the central station working in series, working through each other; that is to say, in the hydraulic analogy two pumps working in series so as to send the water from the pumps at a very high pressure, if such a thing could be introduced into hydraulic engineering. The supply mains come from the extremities of two wires, but there is a third supply main which comes from the intermediate point and connected between the two dynamos, and the lamps are attached to branches which may come from the first main to the intermediate, or, as it has been called, the compensating main, and some of the lamps are attached to branches which are connected with the last main and the compensating main in the middle. By this means we are able to use twice the E. M. F., twice the pressure, by using the dynamos in this way. Of course a great difficulty, as I have mentioned, would occur, were it not for this central connection of the compensating wire; if there are more lamps in use in the first series than in the second series, then it would be necessary to drive the first dynamo so as to give a greater current than the second dynamo is giving, and then, by adjusting the pressure of the two dynamos, we are able to give a constant supply to both sets of lamps, and at the same time to work them in series. This line here is supposed to represent a point of very large consumption, such as a theatre, when the wires come some from the first main and compensating conductor, and some from the second main and the compensating conductor, but in about an equal number, so that if the theatre is put out of a sudden the disturbance in one series of mains will be the same as in the other, and there will not be that change in the light shown you just now.

ECONOMY OF THE MULTIPLE SERIES SYSTEM.

Now as to the economy of this system. In the first place, you will notice that, as I have arranged it here, which is the manner in which Edison has used it, the fall of potential is at the same rate as it is with the ordinary multiple arc distribution; therefore, according to this way, in which lamps are led off from two pairs of mains at every part, the distance to which these mains can extend is still limited, as it was in the multiple arc system, to 124 yards. But it would be equally possible to use only the first main and the compensating main up to a distance of 124 yards, and then to use the compensating main and the second, the lower potential main for another 124 yards. Now as to

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the economy. A great deal of exaggeration has been introduced in America into the accounts of economy in this system. It has been said that, since you are using only half the current when you double the number of dynamos, therefore you have half the size of mains; but then you have three mains instead of four; therefore, they say, you have a gain of 25 per cent. for that reason; but then, they also say, you have got twice the pressure you had before, and again you may halve your mains, and, altogether, they tell you, you can make a saving of copper of 62½ per cent. Now, this may suit American financiers, but it is not electrical engineering. As a matter of fact, in the two cases, in the place of having one dynamo and one pair of mains, I introduce two dynamos and three mains. I have half the current passing through that wire, and, therefore, I may have half the diameter of it, but there is no further reduction possible. I assume that I may take it for granted that the axiom which we worked out in the first lecture must be accepted as an axiom in all future time; that is, that to get economy in our mains we must use the most economical size of conductor possible. In that case, the size of conductor is simply proportionate to the current it has to carry; therefore, the total amount of copper you have to lay down is simply three-fourths of the mass of copper which would be laid down in an ordinary multiple arc system. At a meeting of gentlemen interested in electricity lately, this subject was broached, and I ventured to mention this point, then simply because the originator was present, and I may say that Dr. Hopkinson thoroughly coincided with me in the views I have given you, so that it is evidently purely an American idea.

If we increase the number of wires from three to a larger number, then we increase the economy, but if all the wires are of the same size, then the limit of economy, the maximum of economy would be to reduce the copper by one-half; but it is possible to reduce the compensating wire to one-half, and I should think it might be reduced to one-half, and in that case the limit will be one-fourth; that is to say, when you put a large number of series, you will have about one-fourth of the copper which you have otherwise in a multiple arc system. However, if we wanted to be absolutely certain that our lamps would be in perfect working order, and that our conductors would be of suitable size, perhaps it would be right that all these three conductors should be of the same size, because such a consumption might arise. I am not of this opinion, but suppose we say that, then would come the question whether it is not possible to devise some other means of reducing the thickness of these intermediate wires, these compensating wires. And this is what Mr. Edison has accomplished, on paper at least. In a very interesting patent which he took out in 1883, he has described a means of switching over the lamps from one pair of mains to the other. Now I believe there is a great deal in this, and I believe it is possible in this way to make the householders themselves regulate their supply to a great extent. Just think what you do with your own gas; when you first light your gas, if your burners are as bad as burners usually are, your light flares, and you have to turn it down; after a time, when everybody else is using the gas, you have to turn it up again; then, late at night, when everybody has gone to bed, and you are hard at work, you require again to lower it. If every householder had a switch so that he could switch his own lamps on to one pair of mains or the other, when he found his light dull he would fiddle away with his switch, and in that case he would not only make his own light better, but everybody else's, and every person in the district would be helping the others to acquire the right potential. No knowledge of electricity is required; no householder has to know what he is doing; he has simply to follow the natural instinct which a householder has of fiddling with his gas jet until he gets it the best way possible, and thus it is just possible that to some extent that may be of use. Mr. Edison proposed to use this system of switches, with the three-wire system in combination with it, so that he will not get a perfect compensation by either the one or the other; by the combination of the two he will get a perfect system and a perfect compensation. He has also proposed, in the same patent, to introduce automatic switches, switches which may be influenced by the pressure of these mains locally, or switches which may be influenced by the person in charge at the engine house, so that wherever there is a deficiency of potential lamps may be switched over. It is very probable that some development on this line may lead to important results. I have myself tried to extend the system a little, not in connection with the three-wire system, but in connection with the simple two-wire system.

Now what is necessary in order that we may have equality of current in different sections of these series? It is necessary that we should be able to switch over one or more lamps, or one or more houses supplied with lamps from one to the other. Now what I should propose in this system would be the switching of the mains over. In this case the main, which is connected to each house, is broken between each pair of houses, and I can connect them simply by putting the second main there to the left, the fourth to the left, the sixth one to the left, and so on, and doing the same with the negative main, I should get exactly the same distribution, and I could vary with such a system as this the number of series that there were; I could connect half a dozen of these branches of mains together, and then 12 of these below, and then go on in the same way, from step to step, and introduce only two or three series in the whole of this circuit, or I might introduce as many as 20 or 30, just as I pleased. If one had a very long circuit over a lamp district, one might arrange them in any number of series one pleased, and one could switch over a house from one main to a main of higher pressure, or from a main of high pressure to a main of lower pressure.

CONCLUDING REMARKS.

Now the time has come when we must conclude this course of lectures; and, in conclusion, I have only to say that I think you will all agree with me that, when we attack the problem of electrical distribution in a serious vein, we find that it is rather simpler than it seems at the first blush. It has been well said by one of our most distinguished electricians that in the past the distribution of electricity has been the *crux* of electric lighting; it has been there that the difficulty has been. Undoubtedly the electric lighting act has done an enormous deal to hinder electric lighting, but every electrician must admit that there has been a difficulty in the question of distribution; and I think you will all agree that the further we go into it, the simpler are the rules which guide us, and it is only that schemes have generally been commenced in a slightly haphazard fashion that difficulties of a serious character have seemed to present themselves. In every special district the engineer must use his discretion as to the kind of distribution which he is going to employ. But even in large districts, I think you will all agree that the consideration we have given to it shows that it is a possibility to lay mains on economical principles which shall suffice for lighting large districts, if no undue hindrance is put in the way of enterprising undertakers by the authorities that are in power. The past history of electric lighting has chiefly dealt with the system which I first spoke of in my last lecture, the multiple arc system, but I do not hesitate to say that the future of electric lighting, on a large scale, will deal almost entirely with the systems which have been touched upon to-day. And especially I would draw attention to these different schemes and their value for the reason which I have already mentioned, that in the future we may have inventions in secondary batteries, or we may have other inventions, but whatever invention there is favoring electric lighting, it will be of a nature suitable

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for using the thinner conductors, which we would naturally lay down with any high potential system which I have spoken of this evening. Therefore, the engineer, in designing a system of mains, would have a natural bias towards such thin conductors, such high potential mains; for that reason he would advise it, as well as for other reasons. When we are able to use, as I confidently believe we shall, a pressure of 5,000 volts, we can diminish the thickness of our conductors to one-fiftieth part, and for a district of 50,000 lights we should only require a conductor of about an inch section of copper. When we are leaving the idea of masses of copper of the size of a man's body, and coming down to masses of copper an inch or even two inches in diameter, I think we are really coming to the question of practical electric lighting. And all this has been done—is not merely theoretical; it has been done to a considerable extent already, and that is the direction in which progress is being made at the present time.

I can only say that I hope the Parliamentary difficulties which have partly stood in the way of electric lighting in the past will soon be entirely removed, and that others will prosecute the question of electric distribution, so that we may be all thoroughly ready for it when we have greater facilities for electric lighting in the future, because there is not the slightest doubt that the question of distribution had not been sufficiently developed when the electric lighting act was passed, and if we are ready in the future when those great concessions which must be granted by this or a succeeding government—because it is simple justice—when those concessions have been granted, let us trust that engineers will be perfectly ready and be able to supply a scheme which is perfectly satisfactory. (Applause.)

Mr. Preece, in proposing a vote of thanks to Professor Forbes, took the opportunity of indorsing what the lecturer had said with reference to the danger of high potentials. He was quite sure that electricians were far more able to protect the public from even 50,000 volts than gas engineers were to protect the public from explosions, or ordinary steam engineers from bursting boilers.

Professor Forbes suitably acknowledged the vote of thanks.

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 208.)

In jointing copper lines, if soft copper is used, the ordinary twist joint as already described may be employed. For hard-drawn copper wire such as that employed in telephone, trunk, or in telegraph lines, it does not answer, as it is apt to break the wire. Two other methods present themselves ; one of which like the twist joint requires no other material than wire in its formation ; the other requiring a socket or casing. The first mentioned is the Britannia joint. After many trials of other devices this has been almost exclusively adopted on the British telegraph lines, and when well made it is a wonderfully effective splice. A view of it is given in figure 14. In making it, the ends of the wire are to be scraped clean and bright for about two inches ; they are then laid side by side as shown in the figure, and held tightly together while they are carefully bound over with No. 16 wire of the same material.

In jointing copper wire, the binding wire must be a little softer than the line wire. When this is done the whole is well soldered and makes a homogeneous, and first-class splice. Some copper wires which were so jointed under the supervision of the writer, were afterwards tested by a hydraulic machine, and the wire parted, in preference to pulling out the joint in all cases. It should be here noted that in soldering the Britannia joint in copper, the solder should only cover the middle portion of the joint, as if used over the whole of it, the wire near the end of the splice becomes brittle.

The turned up ends should finally be cut off close, to prevent them from hooking parallel wires when blown about by the wind and causing crosses.

The remaining plan which may be adopted is to place the two ends (cleaned of course) in a metal socket or

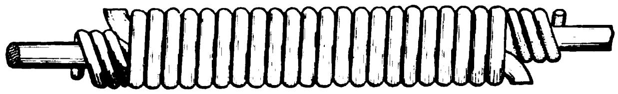

FIGURE 14.

sleeve, such as indicated in figure 15, and then to fill the interstices, and surround the whole with solder. Several patents have been taken out for such devices. One of the earliest is as good as any. It is that of Cary, patented June 20th, 1871.

The sleeve (which should be of the same metal as the line-wire) is enlarged internally about the middle, and has a hole through the centre from side to side. The wires are brightened and the two ends are inserted in the sleeve, one in one end and the other in the other end, so as to meet and overlap one another. A steel punch is then driven through the hole in the side of the sleeve, which forces both wires sideways into the enlarged chamber at the middle, leaving a space between them in which a rivet is passed which is hammered down.

The joint after being soldered over is complete. No joint of this class having projecting screws or lugs is admissable, as such excrescences are quite apt to hook to other wires. For the same reason no joints or splices ought to be made more than 12 feet from a pole ; when at a greater distance they are likely to hitch to other wires; and if it is ascertained before stringing the wire that a joint will have to be made in the middle of the span, it is better to shorten up the end so as to bring the joint nearer the pole.

A small soldering stove should be carried along, so that a supply of melted solder may be at all times ready. It is not a good practice to pour the solder over the joint ; a better way is to dip the centre of the joint entirely into the melted mass. The best solution as a flux for soldering iron wire is chloride of zinc, made by dropping a few small scraps of zinc in hydrochloric acid. The solder makes a solid metallic mass of the joint, which is then as sound and durable as any other part of the line-wire. Any excess of the acid must be wiped off so as to prevent it from acting on the wire. In soldering copper wire, chloride of zinc

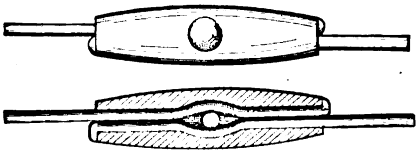

FIGURE 15.

should not be used ; neither should it be used in joints between iron and copper wires. Rosin is the only safe flux to use for such work. Hard wire must be soldered at as low a heat as possible, so as not to soften the metal and weaken it.

TERMINATING WIRES.

The usual way to terminate a wire is to wind it once round the insulator, and then bringing the end back parallel with the wire to give some half dozen or more turns round it.

This can readily be done as in figure 16, with iron wire not over No. 9 in size, or with soft copper wire ; but with

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hard, copper wire, or very large iron, the better way is to terminate the line in the way shown in figure 17, by wrapping the line once round the insulator, or knob, bending it up to shape, and then binding it round with wire not over

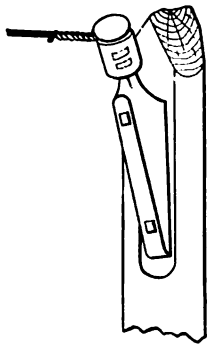


FIGURE 16.

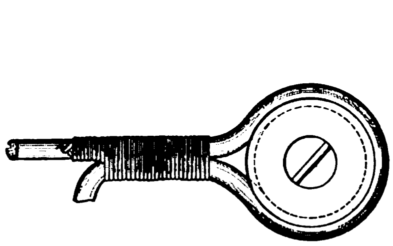


FIGURE 17.

No. 16 in size. The binding wire in such a case as this, need not be soldered as it is not a connection affecting the continuity of the line.

RUNNING HOUSETOP WIRES.

Many of the remarks already penned are applicable alike to pole and housetop lines—and there is very little to add which is specially pertinent to over-house construction. There is much more guying however to do. The slightest turn or angle should be guyed. Nothing but the very best extra B. B. wire should be used, if iron wire is employed; and wherever cables can be introduced, on a line where there is a multiplicity of wires, it is a good thing to use them, as there is no neater way of carrying a number of wires from point to point. Wherever possible wires should cross streets at right angles, as by so doing the risk of accident by breakage is much diminished. A most important point in housetop work is one which is quite frequently neglected—*i. e.*, to keep the roofs quite clear of odds and ends of wire and other debris which rusting, accelerates the oxidation and wearing out of the roof.

ELECTRIC LIGHT WIRES ON TELEGRAPH AND TELEPHONE LINE SUPPORTS.

It has been a question which has been freely discussed, whether in case electric light wires are suspended upon electric communication supports, they should be placed above or below the other wires.

With telegraph lines the only danger if the lines are well insulated is that of actual contact, which can be reduced to a minimum by good work. But with telephone lines the case is different. Not only by actual contact, but also by induction do the voluminous currents of the electric light affect the extraordinarily sensitive instruments which reproduce vocal utterances.

It is therefore not wise to permit light wires on telephone supports at all, unless they are better insulated than they usually are, and unless they are run as metallic circuits with both wires near together on the same support. Viewing the case in all its aspects, it seems best if the different systems *are* to be run together, to place the wires of the lighting system on the top, and to make an unusually high structure for that purpose. It ought also to be put up in an extra strong manner so as to stand an abnormal strain. When a wire carrying a heavy current is so placed it involves two solid advantages which are:—first, that linemen going up the pole or fixture to examine or repair other wires do not have to jeopardize life or limb by passing over a dangerous wire every time; and second, that should the wire carrying the lighting current break down, it is but one wire to fall over the top wires of the systems below, while if it should be placed below everything, scarcely a wire could break and fall, without passing over and contacting with the line-wire.

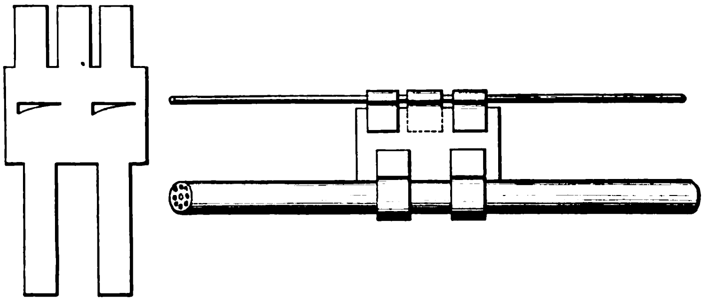
CABLE SUPPORTS.

Various styles of suspension wires, or as they are wrongly called by telephone linemen "guys," are used, and many different ways of hanging the cable to them are adopted.

The suspending wire should be of steel or the best iron wire, No. 4 to No. 6 in size according to the size and weight of the cable. No. 4, I think, is to be preferred; the supports must be strong, and the wire well anchored at both ends, and securely fixed wherever opportunity is afforded. A strand composed of seven or eight No. 13 or 14 wires, or of three or four No. 6 iron wires is better in every respect than a single wire, and is more reliable. It should be guyed to balance lateral strain, and to maintain rigidity, but should not be stretched tight; for the reasons which I have already set forth. In the matter of suspending devices, nearly every one concerned in the erection of aerial cables has his pet clip or attachment.

In New York a favorite method has been to clasp the cable and suspending wire with a reel of marlin or tarred yarn or cord, and then drawing the reel forward, the cord (previously fastened by one end at the starting point) is caused to surround both suspending wire and cable in long spirals. This method was invented and first applied by Mr. C. E. Chinnock.

In some cities the cable is suspended simply by double hooks of the well-known pothook form, endeared to us by childish association with our first essays in the art of caligraphy. These hooks are made from line wire varying in size from No. 10 to No. 8. Sometimes again slings of tarred canvas are used, but these can hardly be considered durable.



FIGURES 18 AND 19.

Another form of hanger was devised by Messrs. Eckert and Seely, now of the Metropolitan Telephone and Telegraph Co., New York. It is made of sheet or galvanized iron. The blanks are cut out of the iron; and the upper edge is cut into three arms with spaces between them, which arms are lapped over the suspending wire. Figure 18 shows the blank as it is cut, and figure 19 the appearance of the clip when made up and attached.

Two horizontal slits are cut in the central portion of the iron, and the lower edge is cut into two long fingers, which when bent over, can be thrust through the horizontal slits, and a socket is thus formed in which the cable lies.

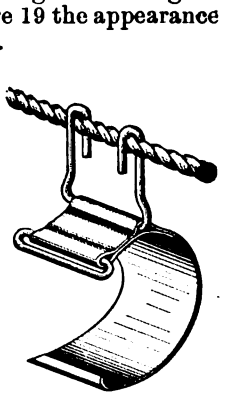


FIGURE 20.

Another good clip is that of Mr. Wright, of Providence. It is illustrated in figure 20. Description is scarcely necessary since the cut is quite clear and speaks for itself. It is made of very strong sheet metal, and when the cable is inserted the free end is hooked up into the link provided for it where the strain holds it securely. As shown it is provided with a double hook, and one size of clip will fit several sizes of cable.

(*To be continued.*)

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THE FREEMAN TELEPHONE PATENTS.

On the 19th of May, 1885, two patents were issued to James P. Freeman, of Chicago, Ill., for improvement in methods and apparatus for telephone transmission, which have apparently excited an unusual amount of interest in electrical circles, if we may judge from the number of newspaper paragraphs which have been sent us, and the considerable number of inquiries we have received as to the character of the invention. A critical examination of these patents shows conclusively that the real object of the patentees was to obtain from the United States Patent Office a *prima facie* endorsement of the claim of the inventor to the possession of a telephonic transmitter, which operates by make-and-break, or interruption of the current, and hence professedly upon a method which differs essentially from that of the Bell patent, and accordingly does not infringe it.

The construction and mode of operation of the apparatus will be readily understood by the aid of a brief explanation in connection with the accompanying drawings, in which figure 1 is a view in elevation of the transmitter box with its door open to show the interior parts, and figure 2 is a detached view showing the manner in which the electrodes are mounted.

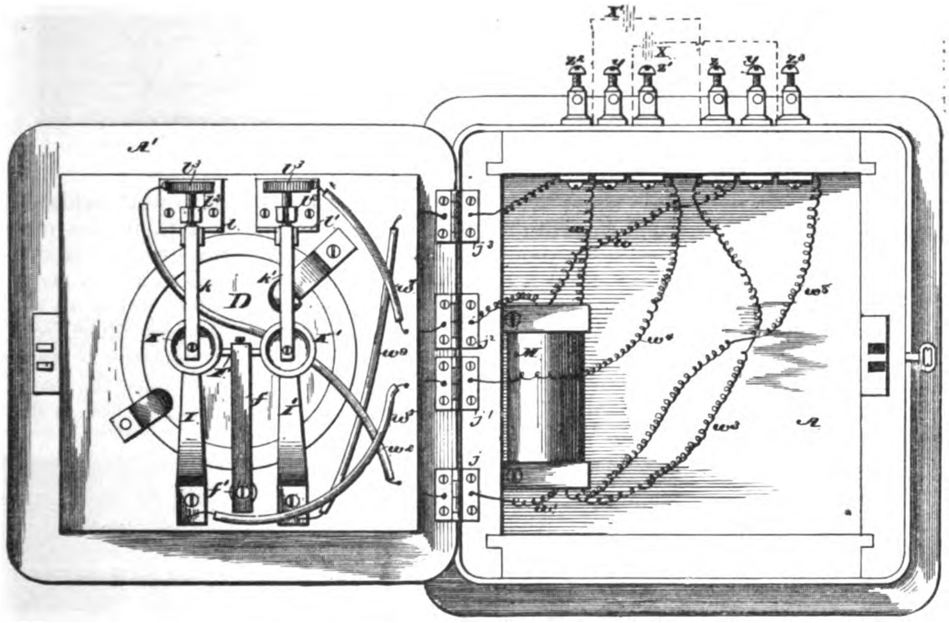

Figure 1.

This instrument in its organization is to all intents and purposes, a double-barreled Blake transmitter, that is to say, it has two sets of Blake contacts thrown into vibration by one diaphragm. The contacts consist of a metal electrode, *h*, and a hard carbon electrode, K. Each metal electrode, *h*, is carried on the end of a long slender spring, I, which tends to press it towards the carbon electrode, K, and each carbon electrode is carried on the end of another long slender spring, *k*, to which an adjusting screw, l_3, is applied so that the latter can be pressed towards the metal electrode. The carbon electrode is mounted in a brass thimble, and is like the Blake electrode, especially in respect to being heavy enough to possess the requisite inertia. The diaphragm, D, through an intermediate pin presses on the bar, F, that carries the two metal electrodes, in such a way that the vibrations of the diaphragm tend to move these metal electrodes towards or away from the weighted carbon electrodes. An independent local battery circuit is provided for each set of electrodes. So far the instrument is nothing more than two sets of Blake contacts connected with one diaphragm, and when spoken to the inevitable result is to produce the precisely same kind of an "undulatory current" that the Blake instrument does, and to do it by the same mechanical means, viz.: the combination of carbon and metal electrodes, each carried on the end of long springs, one vibrated by the diaphragm, and the other provided with a weight at the end of the spring. These two metal electrodes are mechanically (though not electrically) connected with a bar, F, which is pivoted near its middle like a lever. It is easy, by means of the adjusting screws, l_3 l_3, with which the instrument is provided, to keep both of the contacts permanently closed, and in such case the instrument operates precisely the same as two Blake transmitters mounted on the same diaphragm. There would obviously be no difficulty in adjusting them, so that they would slightly rock on the axis, *c*, and break contact alternately, each closing its contact at the same instant the other broke. In this case there would be a continual contact somewhere, although it would be first on one electrode and then on the other, a somewhat similar effect to that which is obtained in another well-known instrument.

The inventor alleges that he turns the adjusting screws so that one contact shall break an instant before the other closes, and that there consequently is an instant when there is absolutely no contact, but inasmuch as all the contact parts are mounted on the ends of long springs, it is wholly improbable that this takes place in any ordinary use of the instrument. The inventor, however, says that even if it does take place, the period of break is so short and so slight that it does not practically interfere with the transmission of speech. No one familiar with the operation of the telephone will believe that *any* breaks occur when it is transmitting good speech; but if the statement in the specification be correct, then the construction of the instrument, as well as the inventor's own description of its method of operation, shows that each contact, during nearly all the time, is simply engaged in producing an undulatory current, precisely like that of the Blake, upon which is superposed a greater or less number of breaks so short as not to prevent speech from being understood. The statement in the specification is that "while it is true that there is an instant of time between the breaking of one primary circuit and the making of the other, and *vice versa*, the making and breaking of such circuits are so rapid that every word and every part of every word spoken in front of the instrument is taken up and transmitted clearly and distinctly. This result is due to the peculiar construction of the instruments embodying the invention in each of the forms shown."

The two pairs of contacts are included in independent primary circuits, but those circuits go through two primary helices connected with the same induction coil, which is furnished with only one secondary, so that their effect is at least as good as if they were arranged in the same primary circuit. The inventor also winds the two primaries in what may be termed reverse directions, or, in his own words, "such that the breaking of one induces a current in the same direction as it does in the closing of the other." It may be remarked that this tends to compensate for any disturbance which might otherwise be produced by the imperfect mechanical action of the rocking lever, the effect of the rocking on one pair of electrodes being compensated by its reverse effect upon the other.

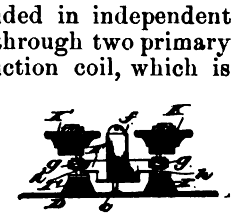

Figure 2.

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The whole apparatus is nothing more than a repetition of the attempt which has been so frequently made, to arrange an instrument which can be called a "circuit-breaker," because the parts are capable of being so adjusted as to be out of contact, but which, nevertheless, is provided with all the necessary operative contacts, so mounted on the extremities of long and weighted springs that when the instrument is spoken to, they are normally and habitually in contact, and produce the ordinary undulatory current, in spite of occasional interruptions by breaks too slight, or, as the patent says, "too rapid," to prevent speech from being understood.

The descriptive portion of the specification is substantially the same in the two patents. No. 318,424, which relates to the specific construction of the apparatus, does not call for special comment. No. 318,424 has the following claims:

> 1. The method of transmitting articulate speech telephonically, which consists, first, in causing primary intermittent electrical impulses in the transmitting circuits through the agency of sound-waves due to articulate speech; secondly, causing said primary impulses to generate secondary electrical impulses of an alternating nature; thirdly, causing said secondary electrical impulses to actuate a receiving telephone at a distant station, and reproduce said articulate speech accurately and clearly, substantially as described.
>
> 2. The method of transmitting articulate speech telephonically by causing intermittent electrical impulses to traverse an electrical circuit, and thereby generate secondary electrical impulses, which secondary electrical impulses in turn actuate a telephone receiver, and cause it to accurately reproduce the aforesaid articulate speech, substantially as described.

It will be noticed that these claims, especially the second, are modeled upon the fifth claim of the Bell patent, and that the method claimed is nothing less than the telephonic transmission of articulate speech by intermittent electric impulses.

From the description which we have given of the mode of operation of the apparatus, nothing can be more certain than that the transmission of speech by it is in fact effected *in spite* of the intermissions in the current, and not *by reason* of them. This is a very important distinction, but is one which has already received such thorough discussion in the technical journals that it seems hardly worth while for us to add anything to it. Nevertheless, it would be interesting to know by what means the Patent Office was induced to grant a broad claim for a method of transmitting articulate speech by intermittent impulses, based upon a specification which really describes nothing of the kind, but, on the contrary, a transmitter operating to produce undulatory impulses precisely like the Blake transmitter. The fact that the late Commissioner of Patents, E. M. Marble, appears as the attorney of the inventor, and also as the assignee of nine-twentieths of the patents, is perhaps sufficient to indicate the nature of the influences which were probably brought to bear to secure the allowance of this extraordinary claim. The careful observer cannot fail to be impressed with the peculiarly funny circumstance, that the inventor of this telephone should have adopted the precise mechanical arrangement which was found by such a careful experimenter as Blake to be adapted to secure the widest range of variation of pressure without interruption, and applied it unaltered to the purpose, as he asserts, of producing very minute and carefully regulated breaks, requiring the most accurate micrometrical adjustment.

Without expressing an opinion as to the value of this invention from a practical point of view, we may say that there can at least be no doubt that the patents are admirably adapted to form the basis for a heavily capitalized stock company, in order that its philanthropic promoters may make one more attempt to rescue their oppressed fellow citizens from the relentless grasp of the alleged "telephone monopoly."

ON CHARGING SECONDARY BATTERIES.[1]

BY WILLIAM HENRY PREECE, F. R. S.

1. I have for some months past been experimenting with secondary batteries with a view of getting an efficient, uniform, and constant source of currents for electric lighting my house, and I have succeeded beyond my expectations. Some new facts have developed themselves during my experience, which I have thought of sufficient importance to bring before the Society.

2. The cells are of the Planté type, manufactured by the Elwell Parker Co. of Wolverhampton. Fourteen plates of

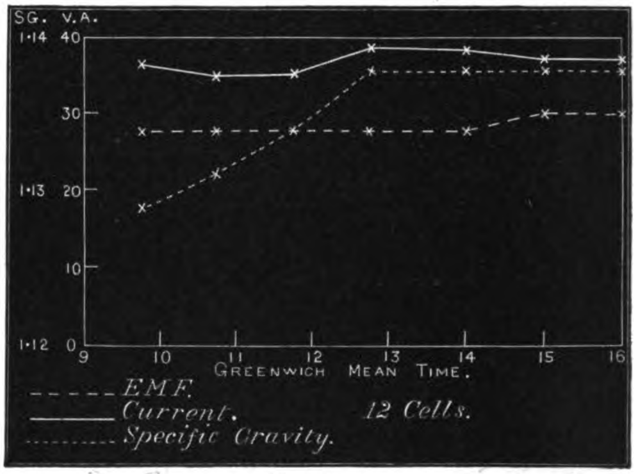

FIGURE 1.

plain sheet lead 17″ × 11″ are suspended in well insulated wood boxes filled with diluted sulphuric acid in the proportion of about 1 to 10. These plates are grouped in two groups of seven, each group being soldered to a lead strip, forming alternately the positive and negative poles of the cell. The plates of the respective poles are prevented from touching each other by ebonite grids or separators.[2] Each plate offers a surface of 1·3 square feet, so that the total surface of lead of each group opposed to each other is 9·1

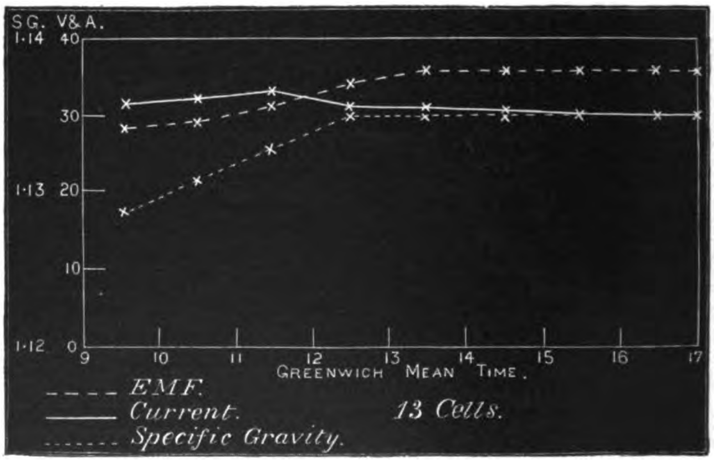

FIGURE 2.

square feet; that is 9·1 square feet of peroxidized lead is opposed to 9·1 square feet of spongy lead.

3. My charging current varies from 3 to 3½ ampères per square foot, while the current of discharge used in lighting my house varies from 1 to 1½ ampères per square foot. The total weight of each cell is 120 lbs. The plates are prepared by the Parker-Planté process before insertion in the

1. Read before the Royal Society, May 21, 1885.
2. These ebonite grids were introduced by Mr. Charles Moseley, and have effectually removed one incessant source of trouble in these cells, viz., short-circuiting through the buckling of the plates.

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cell, those forming the positive pole being well peroxidized, while those forming the negative pole are well coated with spongy lead.[3] They are thus, when put together, prepared at once to be charged. If they are not at once charged, local action sets in, and lead sulphate is injuriously formed.

4. I have cut away a small portion of the centre of the central plate of each cell to admit a hydrometer, having a scale graduated from 1·050 to 1·150 (Frankland, "Proc. Roy. Soc.," No. 224, 1883). The changes of the density of the liquid and of the color of the plates give the fullest and clearest indications of the behavior of the cell. The condition of the surface of the peroxidized plate as felt by the finger is also good evidence of its condition. If a plate is yellowish-brown and rough, it probably makes bad contact with the lead terminal; if black and hard, it wants the density of current regulated; if plum-colored and greasy to the touch, it is in good order, and working well. Now that my plates have been in use for some time they seem far less inclined to local action. In the oldest cells no local action is evident.

5. At the present time I am charging my cells twice a week, putting in at each charge about 120 ampère-hours. During charge observations are made every hour, and sometimes every half-hour,—(1) of the strength of current flowing through; (2) of the electromotive force; and (3) of the density of the liquid of one or more of the cells. The relation of these three quantities tells me the condition of the charge. The diagrams herewith are typical cases :—

Take No. 4, which is the diagram of this morning's (April 28) charge of 15 cells. The following are the particulars :—

	E.	C.	D.
9.0 A. M.	37·7	32·24	1·115
10.0 "	40·2	32·24	1·119
11.0 "	42·5	31·50	1·121
12.0 noon	42·5	30·74	1·123
1.0 P. M.	42·5	29·95	1·124
2.0 "	42·5	29·95	1·124

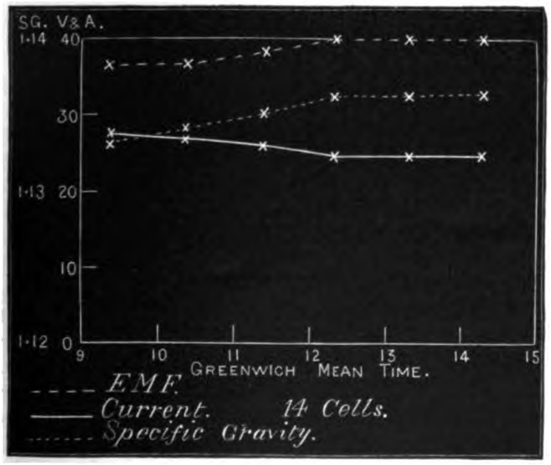

FIGURE 3.

6. It is evident that after four hours continuous charging the battery was full, for the density, the electromotive force, and the strength of current became constant. The same scale of ordinates is used for volts and ampères. When each magnitude reaches its constant, bubbles of gas are freely given forth, and energy is being wasted. The variation of the electromotive force and current strength is clearly due to the counter-electromotive force of the cells, which becomes a maximum only when the plates are fully formed. The counter-electromotive force partakes of the character of a higher resistance opposing the charging current, and increasing the proportion of the current through the shunt of the dynamo. Hence the changes of electromotive force are more marked than those of the current. Indeed, the changes in the electromotive force, as given by the voltmeter, are sufficient alone to indicate the progress and completion of the charge. They are more reliable than the evolution of gas. My dynamo is a small Gramme shunt-wound, my voltmeter is Cardew's, a most reliable, simple, and valuable instrument, and my current meter a Siemens' electro-dynamometer.

7. I was at first much troubled with electrical leakage. The current escaped over the edges of the box, wet through

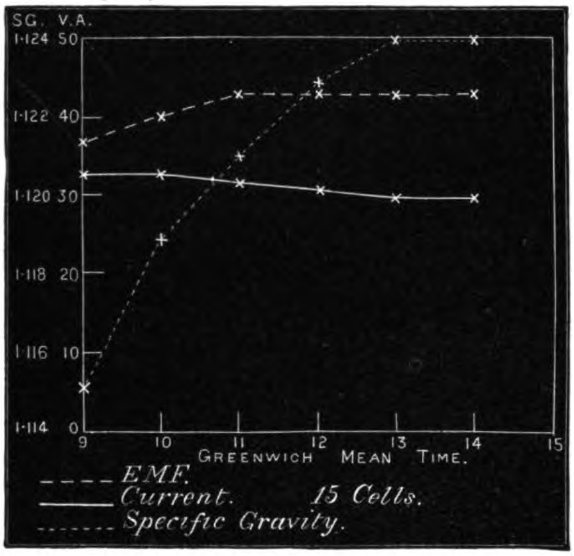

FIGURE 4.

creeping by capillary action, and the formation of moisture from the spray of the solution when bubbles of gas arose in the liquid and burst on the surface. This was quite cured by standing each box on three white porcelain supports of the form shown in the following figure, the cups being half filled with resin oil on Messrs. Johnson and Phillips's plan. It is now quite impossible to measure the leakage except with a delicate galvanometer, and it may be said to be practically perfect.

8. The E. M. F. of the battery at its terminals :—

When charging.......... .... 2·25 per cell.
When idle.................... 2·05 "
When discharging............ 1·90 "

The internal resistance[4] is, per cell :—

When charging.................. ·0060ω
When discharging.............. ·0017ω

9. But the latter varies very markedly with the strength of current of discharge. This is shown by the following experiment made with 23 cells of a smaller type than those described above, which are used in the post-office.

Current of discharge in ampères.	Internal resistance in ohms.
4·39	0·7608
7·25	0·4607
15·84	0·2816
25·07	0·1969

10. Thinking that this remarkable diminution of internal resistance might be due to the evolution of heat, I measured the temperature with a delicate thermometer.

Normal temperature of cell 12½°C. Current of discharge :—

5 ampères.... No alteration of temperature perceived.
10 " .... An exceedingly slight change.
16 " .... About 12¾°.
20 " .... Barely 13°.

3. The Parker-Planté process consists in immersing for a few hours the lead plates in a solution of nitric and sulphuric acids in these proportions—
Nitric acid.......... 1
Sulphuric acid.......................... 2
Water.. 17
before fixing in the cells. This not only chemically cleans the lead surfaces, but it favors the formation of sulphate of lead in such a way as to be readily converted into lead peroxide and spongy lead on the passage of a strong current through the cells. The formation of the cells is thus greatly expedited.

4. The term "internal resistance" means the effect of counter-electromotive force as well as of resistance to conduction.

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The current in each case was kept on for 20 minutes, hence it is not due to heat. Since the internal resistance varies in this way, I now always take the internal resistance with the same current, viz., 10 ampères.

11. The capacity of these batteries certainly improves with age, and up to the present time I have seen no sign of decay or deterioration. M. Planté informed me that, though in course of time the peroxidized plate becomes very brittle, it is impossible to peroxidize it completely through ; there always remains a metallic core to give it strength. My experience of these plates confirms this. Up to the present moment I have made no careful measurements of the efficiency of my battery. I cannot do so without deranging the lighting of my house, and I regard observations on single cells as illusory for they are so very variable. I put in about 240, and I take out about 200 ampère-hours weekly, and I do not observe any change or fall in the electromotive force. When the electromotive force of these cells falls, it falls rapidly, indeed, almost suddenly. Occasionally one plate of a group becomes inactive from undue local action, or from bad connection (shown by the color). I remove this cell and put it in what I call a "hospital" cell, where it is brought into order either by a greater density of current or by reversal.

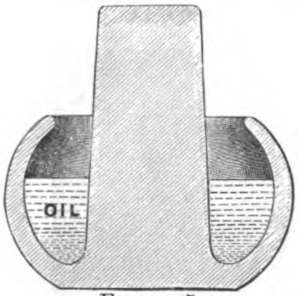

FIGURE 5.

12. Reversing has a great beneficial action on a cell ; it not only improves its capacity, but it removes any cause of irregular working. It is advisable to do this periodically. I have two extra cells, which enables me to have two cells always under reversal by means of the charging current. It takes from 1,000 to 1,200 ampère-hours to reverse my cells in the condition they are in at present, but this will vary with the amount of lead peroxide which has to be reduced to spongy lead. Hence at this time of year it takes a month or more to complete the operation, and it will take a year to reverse the whole battery. I have up to the present time reversed 16 cells.

A NEW APPLICATION OF ELECTRICITY.[1]

A NEW and interesting application of electricity, in a somewhat unexpected direction, has formed the subject of some recent investigations by Mr. Alfred O. Walker, of Chester.

Our readers may have noticed, in the autumn of last year, reports of a lecture read by Professor Lodge, of Liverpool, on the subject of "Dust." Papers were first read by Professor Lodge in this country, and the subject was afterwards more extensively dealt with in a lecture which he delivered at Montreal, during the meeting of the British Association.

In the course of these lectures the professor brought before his hearers the curious observations which he had made as to the effect of a discharge of high-tension electricity from a point, or points, into glass jars or other vessels containing dust of any kind in suspension. He also made interesting and striking experiments illustrating his remarks. Thus if a bell-jar be filled with a dense smoke of magnesia, by burning some magnesium wire inside it, a very long time elapses before the magnesia settles out and leaves the glass clear of smoke. But if a metallic point be introduced into the jar, connected by a wire to one of the poles of a good frictional, or induction electric machine, it is only necessary to set the machine to work, and almost instantly an extraordinary effect is observed inside the bell-jar. The magnesia smoke commences to whirl about and then forms itself into large flakes and strings which rapidly settle on the bottom and sides, leaving the jar perfectly clear of smoke. What would have taken several hours to settle in the ordinary course, is completely cleared and deposited in a few seconds. The same effect is produced if the jar is filled with any kind of smoke, that from thick paper, or from a cigar, being acted upon exactly in the same manner as the magnesia. Professor Lodge told his audience that he and his assistant had made experiments on a very much larger scale than those in the glass jars. Rooms had been filled with dense smoke and rapidly cleared in the above manner.

A report of one of these lectures appeared in our contemporary *Nature*, and was read by Mr. A. O. Walker. This gentleman is one of the partners in the well-known firm of Walker, Parker, and Co., lead smelters and manufacturers, and it at once struck him that in these observations and experiments of Professor Lodge might be contained the means of solving one of the principal problems with which a lead smelter has to deal, viz., the condensation of the "fume," or volatilized lead, from the furnaces. Various forms of apparatus have been from time to time proposed as "fume condensers," but with little or no success, the best results being so far obtained by passing the fumes from the furnaces through long flues and chambers. At the large works belonging to Walker, Parker, and Co., at Bagillt, in North Wales, the flues and chambers have a total length of over two miles, and still the condensation and deposition of the lead fume is far from complete.

Mr. Walker at once communicated with Professor Lodge on the subject, and the matter being considered very promising, it was decided at once to try experiments on a practical scale. These were carried out by Mr. Walker at the works at Bagillt, with the assistance of the manager, Mr. W. M. Hutchings. Professor Lodge himself gave scientific advice and assistance on special points. The results of the experiments, which were carried on during many weeks, were extremely satisfactory, and fully bore out Mr. Walker's hopes and expectations.

By means of large casks a wooden flue was constructed at right angles to one of the main flues of the works, and with a damper on the main flue it was possible to make any required amount of the fumes from a group of furnaces pass into and through the wooden experimental flue. This latter was provided with glass windows placed opposite one another for the purpose of observation. It also had dampers by means of which it could be filled with the furnace fumes and then closed at both ends, so that it formed a chamber representing the professor's bell-jars on a very large scale.

The electric machine employed was on the Voss system, the glass disc being 18 in. in diameter. It was worked in a small shed erected close to the experimental flue. One pole of the machine being connected with the ground, the other was connected to an arrangement of metallic points placed inside the flue, and exactly between two of the windows above mentioned. A well-insulated copper wire led from the pole to the top of a stout brass rod, which was fixed in the top of the flue, projecting some distance above it, and reaching so far into it as was necessary to sustain the discharge points in the desired position. This brass rod was fixed inside a glass tube of considerably larger diameter, in order to insulate it where it passed through the top of the flue. During the experiments several different arrangements of discharge points were used, as for instance a brass ball having spikes projecting from it all around, a ring with spikes fixed upon it pointing in all directions, a cross studded with spikes in a similar manner, &c.

The electric machine, being kept dry and warm in the shed, worked in a very satisfactory manner during all weathers, giving sparks some 4 in. in length.

The first experiments tried were upon the lead fume in a state of quiet ; that is, the flue was filled with fume by allowing a strong current of it to pass through from the main flue, and then simultaneously closing the inlet and

1. *Engineering* (London).

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outlet dampers. The fume thus inclosed in the chamber, when viewed through the windows, appeared as a very dense fog or mist. Left to itself it took many hours to deposit. But as soon as the electric machine was set to work, the same action took place as with the magnesia in the bell-jar. Through the windows could be observed the same whirling movement around the discharge points, and in a few seconds the fog was seen changing into little flakes, like snow-flakes, which rapidly flew to the sides of the chamber, and were there deposited, till in an incredibly short time the "fume" had entirely disappeared from the atmosphere of the chamber, which was as clear as before the fume was let into it.

Further experiments were then tried as to the action of the electric discharge upon the fume in rapid motion as it is in the flues of the works. The damper in the main flue being closed, the whole of the pressure of furnace gases was turned through the experimental flue and allowed to stream out into the air. Then the electric machine was worked as before. No effect could be seen through the windows because the rapid current swept the fume onwards too fast to allow of any change being observed at that point. But at the outlet into the atmosphere, a few seconds after the discharge of electricity commenced, the effect was again very striking, the issuing fume again changing from fog into flakes. A glass plate held in the current before the discharge from the machine began, was only coated, after considerable time, with a thin film. A similar plate held in the current during the working of the machine was instantly coated over with flakes and large separate specks of fume. So much was the fume agglomerated by its passage past the discharging points, that on some occasions in perfectly calm weather some of it would fall to the ground immediately on leaving the exit opening of the flue. In short, the series of experiments proved that what took place under the bell-jar took place equally in the flue of a smelting works, with all the attendant circumstances of heat, moisture, and acid vapors.

The trials of various arrangements of discharge points seemed to show that, within certain limits prescribed by the power of the machine in use, the more points employed the better was the result, the points being spread as uniformly as possible over the cross-section of the flue through which the fumes are passing.

On the strength of the satisfactory results above stated, Mr. Walker decided upon taking measures to apply this new process of fume condensation on a full working scale at the Bagillt works. The necessary plant is now in course of erection, and nearly completed. The electric machines used will be on the Wimshurst system, with discs of 5 ft. diameter. Two such machines have been constructed specially for the purpose by Mr. F. J. Cribb, engineer, of Chester. They will be driven by a small steam engine, the whole plant being placed in a small building close to the main flue of the works, through which pass all the gases and "fume" from nineteen furnaces.

Mr. Walker proposes to extend the process in England and most European countries, and in the United States. It is intended to apply it to other branches of metallurgy besides lead-smelting, as, for instance, the condensation of zinc oxide in the manufacture of zinc-white, and the condensation of arsenic. But its principal field of usefulness will doubtless be in lead works, where so far all the proposed systems of condensers have either failed outright, or proved so costly to erect and to work, that the very imperfect results obtained did not render it worth while to continue their use.

The outlay for the requisite machines, etc., will be a very moderate sum, and the cost of running the apparatus even for large works will be limited to the wages of one man per 12 hours, and fuel for a boiler to develop the insignificant power required to drive the Wimshurst machines. There will be little chance of anything getting out of order, and in case a temporary breakdown of any kind takes place, the work of the furnaces will be in no way interfered with. This is, perhaps, the greatest recommendation of this process in the eyes of managers of works. Any one who has run a works, the draught in which depended on mechanical arrangements, as is the case where fume is to be condensed by sucking or forcing through water, knows what a constant succession of breakdowns and stoppages has to be encountered. Mr. Walker's process causes of course, no interruption of the proper draught in the flues, under any circumstances. Fume which is now carried forward through the longest flues, and escapes from the chimney, will be rendered so much denser by the action of the electric discharge that it will not be carried anything like so far by the draught, and will rapidly deposit itself. Thus, works which have now considerable flues may look forward to obtaining a greatly increased yield of condensed fume, while others which have not as yet considered it worth while to erect flues for the partial condensation to be obtained by their use, will probably find it advantageous to do so, when, by so simple a process as the one in question, they can obtain from a moderate length of flue a greater yield than could otherwise be looked for from a very great length.

When Professor Lodge was carrying on his experiments on "dust" from a purely scientific point of view, it is not likely that he had any idea how soon his results would become of practical commercial value; and the speedy turning to technical utility of these experiments, owing to the sharpsightedness of Mr. Walker, is but one more of the many instances demonstrating the unexpected and often surprising manner in which "pure science" of one day may be very valuable "applied science" of the next.

DESCRIPTION OF A LARGE SECONDARY BATTERY PLANT FOR GENERAL COMMERCIAL DISTRIBUTION.[1]

BY E. P. ROBERTS, M. E.

(General Manager of the Brush-Swan Electric Light Co., of Cheyenne, Wy.)

1st. Description of the storage plant.—2d. Direction for erecting and maintaining storage batteries.—3d. Remarks respecting storage batteries and their field of usefulness.

A description of our entire plant, both arc and incandescent, was published in the *Electrical World* of February 28th, 1885, and from that article will be quoted a description of our battery plant.

The Brush-Swan Electric Light Co., of Cheyenne, was formed in the fall of 1882, and was the first Brush-Swan company formed to use the Swan lamp in conjunction with the Brush storage battery and arc system. Storage batteries were put in operation early in 1883, and at the present time 99 batteries and 1,500 lamps are in operation, distributed over an area about one mile square, the charging station for the batteries being about one-quarter of a mile outside the north-west corner of the square, and over 300 of the lamps being in the south-east corner.

BATTERY PLANT.

"On each block—sometimes on every two blocks—is located a small portable house, in which are placed all the batteries furnishing light for said block. A partition divides it into two parts, one for the batteries and the other for the meters and switch-board. A plug switch is used in order that any combination may be readily effected. Cable connections permit coupling batteries together as desired. An extra battery is kept in each house for use in case extra light is required.

"The batteries are placed on string pieces 2 inches by 4 inches by 10 feet; each cell rests on four porcelain insulators, and the string pieces rest on Western Union insulators, with pins set in cross-pieces. Three sizes of batteries

1. Read before the American Institute of Electrical Engineers, May 20, 1885.

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are used, 1, 2 and 3, with capacities of 20, 40 and 80-lamp hours respectively.

"Three charging circuits are used, two to private residences, where Nos. 1 and 2 batteries are used, requiring from 7 A. M. to 1 P. M. to charge them with a 10 ampère current, and one circuit to the business part of the city, where batteries are used. As these batteries are much larger, a longer time is required to charge them, and, therefore, they are charged from 7 A. M. until 3 P. M. by a 65-light dynamo. They are then connected by switch, as desired, for the night, in some cases three batteries being connected for quantity.

"At dark the charging circuit is looped in with the all-night outside arc circuit, and the charge thrown on about 20 meters, and by the connections for quantity controls about 50 batteries; thus they are left until daylight, when the arc circuit shuts down. By this means the batteries obtain considerable charge; they are then disconnected and charged separately during the day."

Directions for Erecting and Maintaining Storage Batteries.

A. CAREFUL INSULATION.

1st. Battery as a whole well insulated from the earth.

2d. Each cell insulated from all others, excepting, of course, through the proper channel for the passage of current.

3d. The positive and negative in each cell to be insulated from each other except through the liquid. No connection by moisture on the upper edge of the containing box.

B. REGULAR CHARGE AND DISCHARGE.

1st. Fill the battery every day.

2d. Discharge the battery every day.

3d. Never over-charge.

4th. Do not exhaust completely.

C. DO NOT EXPECT BATTERIES TO TAKE CARE OF THEMSELVES.

1st. Test electromotive force of each once a week with a voltmeter.

2d. Test each cell with an acidometer once a month.

3d. Each day see that each cell in each battery fills in the same time.

4th. Keep plates covered with liquid.

5th. Examine all connections frequently.

D. Keep extra cells complete and charged, with which to replace defective ones. Do not put uncharged plate or cell in battery in regular use.

E. Do not "box in" batteries. Give free circulation of air.

F. Keep all connections, switches, etc., as far as possible away from batteries.

G. Study the cause producing a new effect, and attend to details.

REMARKS.

After considerable experience with storage batteries, my conclusion is that they have been both praised and belittled too much. That the service can be good is certain; but that for a closely settled district they are preferable to dynamos is not, according to my experience, correct.

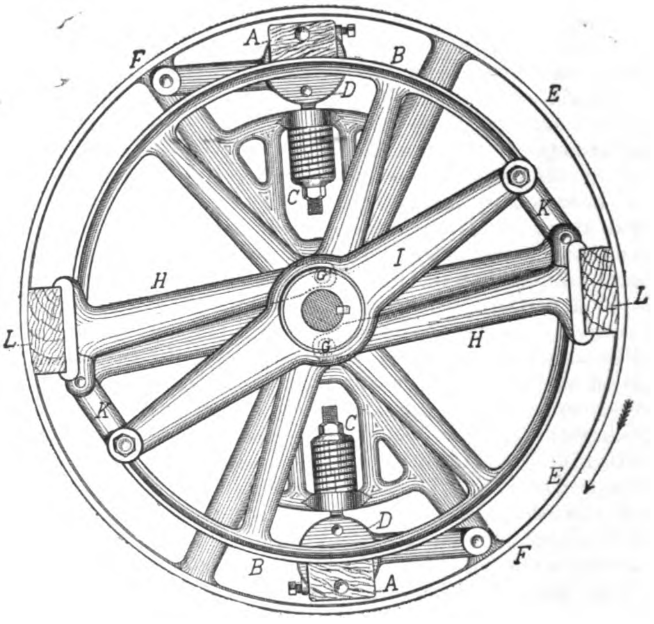
Experience teaches the manufacturers many points in design and formation which greatly increase the reliability of secondary batteries. Experience in handling them teaches men many little matters which greatly assist in keeping the batteries in good condition.

My plan for our new station about to be erected will show, more forcibly than a lengthy disquisition, my ideas respecting secondary batteries in connection with stations for the distribution of electrical energy.

A building is to be erected near the business portion of the city, from which our arc lights will be supplied, and in which also will be placed dynamos for running the incandescent lights in the business district. Batteries will be used in portions distant from the station. These will be charged from 3 A. M. until 7 A. M. with a 15-ampère current. At the station will be several large batteries, which will be used for day lighting or in case of a breakdown.

A GOVERNING PULLEY FOR DRIVING DYNAMOS.

THE irregular speed of the steam engine, as now constructed, has brought into the field various devices to overcome the difficulty. Among others who have directed their attention to this subject is Mr. A. Campbell, well known as a builder of printing presses. Being unable to secure an even blast of air, which was essential to the perfect working of a sheet delivery apparatus for a new press, on account of irregular speed, he was led to invent what he calls the "planet pulley." The uniformity of speed attained by its use (the engine varying 12 per cent. at times) has convinced the inventor that it will prove very acceptable in connection with electric light plants. The necessity of some such device has been keenly felt where dynamos are run in series. The maintenance of uniform speed among the different generators in such cases has heretofore proved a difficult problem.



The accompanying illustration shows the general construction of this pulley, which comes under the broad head of what are known as friction pulleys, except in this case it is a delicately controlled friction that produces absolutely uniform speed.

When at rest the block, A, of the feeling brake is drawn into firm contact with the smooth surface of the supplementary pulley, B, by the spring, C, through the governor ball, D, attached to the arm of the driving pulley, E, at the point, F, binding E and B firmly together. On the hub of B are two studs, G G, as shown by dotted lines. Upon these the arms, H H, are hinged, the outer ends of H being connected to the brake carrier, I, by the links, K K. The brake carrier, I, is keyed to the shaft, and the pulleys, E and B, turn freely upon it. On the opposite side of E are duplicates of the pulley, B, arms, H H, link, K K, blocks, A A, and brake carrier, I. By this arrangement the pulley, E, the governor, D D, blocks, A A, and springs, C C, are embraced between the actuating mechanism, and could be turned freely, provided the blocks, A A, were removed from contact with the rim of the pulley, B. This would occur when in motion, provided the speed was such as to have the centrifugal force imparted to D, sufficient to overcome the spring, C; B and H being linked to the carrier, I, and this keyed to the shaft, they would all then turn freely

without driving the pulley, E; but the instant E slows up sufficient to allow A to bear on B, B would be retarded, causing the arms, H H, to be thrown outward, and bringing the blocks, L L, in firm contact with the inside of the rim of the pulley, E, picking it up and thereby increasing the speed; but the instant it reaches that point where the spring, C, and the work done are equal to the centrifugal force of the ball, D, a sliding action takes place equal to the variation of the line shaft above a fixed speed.

One of the great advantages to be derived from the use of this pulley is that a dynamo may take its power from an engine used for other machinery, and subject to a fluctuating load. Various tests have been made, proving its governing scope; for instance, with 15-h. p. on a three-horse pulley the main load has been cut off, and the engine allowed to run at double its normal speed, without causing a variation of more than three per cent. They are not, however, constructed with a view to a greater change than 10 per cent. of the load. With half the load thrown off, the speed is increased less than one per cent. This variation is a uniform increase or decrease, not an average.

ELECTRIC FIRE-ARMS.

The application of electrical ignition to fire-arms has been brought to such a state of perfection that it is confidently predicted that electricity will eventually supersede the percussion system, now almost universally used for sporting and military arms. In order to do this, however, electricity must be thoroughly proved to possess advantages in various particulars, and, at the same time, be free from objections which will naturally arise in the minds of those who are most familiar with its action.

On the part of the advocates of electric fire-arms, it is claimed that they can be manufactured in quantities for one-third less than those now in use, the principal reason being that the lock is entirely dispensed with, it being superseded by a battery, at a much less cost, which will ignite several thousand cartridges before it is exhausted. The guns can also be made both shorter and lighter for similar reasons. The cartridges can also be made considerably cheaper, no fulminate of mercury being required. A paper or linen case may also be substituted for the metallic shell now required in breech-loaders, the latter being necessary in order to withstand the shock of the firing pin, which strikes the base with a momentum of 18 pounds. The danger arising from poisoning by fulminate of mercury, as well as from accidental explosions either in manufacture or transportation, is entirely obviated or materially lessened.

One of the most important advantages, however, is the ignition of the charge at the base of the projectile, so that the powder burns toward the rear, and combustion is more perfect. This is of great importance in rapid firing, as the gun does not foul so readily, while the explosive force is also greater. The absence of any recoil is another feature due to the ignition of the forward part of the charge. As but the slightest pressure is necessary to close the circuit, the aim is not disturbed, either by pulling the trigger or the blow of the firing-pin.

A cartridge adapted to electrical ignition was invented by E. A. Monfort in 1882, and is adapted to guns of all descriptions. In small arms intended for firing from the shoulder, a small primary or secondary battery weighing about three ounces is enclosed in an ebonite box, and placed in the stock of the gun, from which the conducting wires are led to contact surfaces inside of the cartridge chamber, in one of which a simple circuit-closing device is provided in lieu of the ordinary trigger, which is arranged to be manipulated by a slight movement of the finger. A suitable device is also provided for keeping the circuit open, when not required for use, to provide against accidental discharge. The terminals are so located in the cartridge chamber that the conductors in the cartridge are brought in contact with them in whatever position it may be placed. The cartridge is provided with two conducting wires, leading from the base into the powder. The apex of the loop is formed of a fine platinum wire, which, being heated to incandescence upon the closing of the circuit, instantaneously ignites the powder, and the piece is discharged. Mr. Monfort has since made several improvements, both in guns and cartridges, the patents for which have been assigned to the Universal Electric Arms and Ammunition Company.

These results are readily attained upon an experimental scale, but it is only by practical experience that we may determine whether such a state of universal perfection can be reached as to render the electric fire-arm a reliable weapon under all circumstances.

COPPER AND BRASS.[1]

Copper was the first metal wrought into arms and implements in the territory which is now the United States, if the testimony of the relics of the days of the Indian occupation, and of the records of the Catholic missionaries, does not deceive us. The red metal which underlies the State of Michigan in such priceless deposits early caught the eye of the savage warriors who threaded the forests of the north in pursuit of game and built their camp-fires on every hill. The stone hammers of the early race of men had been employed upon the metal; and the Jesuit fathers who marched with the cross of their religion in advance of the soldiers who bore the lilies of France found great quantities of it worn as ornaments and shaped into tools and weapons by the red heathen whose conversion to Christianity they sought. Had the white man who succeeded to the occupancy of the soil also inherited the civilization of the red man, it is probable that he, too, would have expended his art first upon the working of red copper, before attempting to utilize the less attractive and more refractory metal which now claims his more diligent attention; but the white man brought to America the science and arts of an older and higher civilization, and copper claimed his attention less at the outset than the denser metal. That has not, however, prevented copper from assuming the important rank in the arts of the country to which its qualities entitle it. Its manufacture is one of the greatest industries of the United States.

The first copper mines were opened in Connecticut; and the state employed its convicts for a period of sixty years, ending about 1830, in getting out the metal in the town of Simsbury. The ingots of metal were sold to the mint and to the smiths; but at first by far the larger part was exported to Europe to be manufactured. After 1812, when a duty of 35 per cent. was levied upon manufactures of copper, there was less of metal exported, and more of it made up into plate and utensils for use on this side of the water. The industry developed the fastest in the eastern and middle states. In 1870 there were 391 copper and brass factories in operation, employing 5,600 hands, and producing a value of $15,000,000 in finished goods annually, there being of these factories 29 in Connecticut, 44 in Massachusetts, 85 in New York, 81 in Pennsylvania, and 21 in New Jersey. Ansonia and Waterbury, Conn., became the principal centres of the manufacture.

Pure copper is one of the softest of the metals, and is easily rolled into plates for use. It is in the form of plates principally that it is employed in the arts. Its most important use is in the sheathing of the bottoms of wooden ships to protect them from accumulations of barnacles and shell-fish and the ravages of the borers. The navigators of the early centuries had great trouble with their ships on account of the fouling of the bottoms. It was finally suggested that the protection of the part of the ship below the load line with sheet lead would prevent incrustations,

1. *Pottery and Hardware Reporter.*

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and that material was used for a while. In 1761 the "Alarm," a frigate in the royal navy, was sheathed with copper, which was found to answer the purpose very much better. After a series of years, it was found that pure copper, while protecting the ship, was itself rapidly eaten away by the chemical action of salt water, which made its renewal necessary. This was expensive, and shipping men cast about for some improvement of the process of sheathing. A curious experiment was made in response to a suggestion by Sir Humphrey Davy. This was to place strips of iron under the sheets of copper, which would be corroded by the galvanic action rather than the copper. The invention worked beautifully; the copper was preserved and money saved. But, quite unexpectedly, it was then found that the copper, no longer dissolving in the sea, became covered with barnacles as badly as the wooden bottoms had been before. So the shipbuilders went back to pure copper. After a while, however, an alloy of copper was invented by mixing with it 40 per cent. of zinc, which answered the purpose of sheathing admirably. The alloy was a species of brass. It was called "yellow metal," and still retains the name, and is now universally used for the coppering of wooden vessels. The metal is very soft, and is rolled cold. It is worked down very gradually and carefully from the ingot, being annealed after each rolling, and cleared of oxide by pickling in a bath of diluted sulphuric acid. Owing to the high price of labor in this country, sheathing has been more expensively made in the United States than abroad until within a very few years. Of late the price has been so reduced that the former large importations of it have greatly fallen off, and the sheathing used by American shipbuilders is virtually all American-made. The bolts and nails by which copper sheathing is fastened to the ship are cast solid.

Sheet copper is a very popular material for boilers and cooking utensils in domestic use. The metal resists the action of the fire better than tin and sheet iron; it is, therefore, applied to the construction of many forms of manufacturing apparatus which come into contact with fire, such as retorts and pipes, vacuum-pans, condensers, and boilers in distilleries, sugar-refineries, and other factories. The smaller utensils are formed from the sheet metal by hammering, and by the process of spinning up. The copper becomes very dense and brittle in the smithing process, and has to be annealed constantly as the work goes on. In boiler-making the plates are either united by lapped joints, soldering or riveting, and sometimes by more than one of these methods.

Copper is more extensively used in the form of brass than in its pure state. By admixture with a certain proportion of zinc it gains beauty and durability, and is generally preferred in that form. The best proportion of the metals is two of copper to one of zinc, which makes what is called eight-ounce brass; that is, eight ounces of zinc to 16 of copper in the pound. Sixteen-ounce brass, the two metals being equal, is a beautiful golden alloy, called "prince's metal." Other combinations are made to produce pinchbeck, Manheim gold, and other alloys suitable for cheap jewelry, and ware for gilding and silvering. Brass is as agreeable metal to work as pure silver. In thin plates it can be stamped and embossed in any form. It spins up beautifully in a lathe. It can be drawn out into delicate wire; and is so malleable that it can be beaten out almost like gold-leaf itself for the purpose of cheap gilding. The metal is susceptible of a high polish. It does not rust by exposure, and has a great deal of the beauty of gold. It is the universal material of which chandeliers and gas fixtures are made, being susceptible of rich coloring, bronzing and silvering by chemical processes, and of shaping into the most elaborate forms by stamping and embossing. Brass was at one time the exclusive material out of which the works of clocks were made. Steel works are now beginning to be used to a very large extent; but brass holds its own for all cheap clocks, and indeed is popular in every grade of timepiece up to the great machines put in the towers of our city halls and churches. Its beauty, and freedom from rust, insure its popularity.

STEAM ENGINES FOR ELECTRIC LIGHTING.[1]

The production of engines for electric lighting, is now becoming recognized as an important branch in many engineering establishments. In few cases have special designs been got out for this work. Portable and semi-portable engines have been largely used, but as electric lighting gets beyond the experimental stage, engines of these types become inadmissible for permanent installations, and separate fixed engines and boilers are required. There are doubtless, at the present time, many engines in the market which admirably fulfill all the required conditions, but there are also a great number which fall lamentably short of this, so that a brief discussion of the principal points to be kept in view in designing engines suitable for electric lighting may be acceptable. The points we deem worthy of primary consideration are steadiness in running, good governing, the capability of making long runs without stoppage, and, not least, economy in working. By steadiness in running we mean the maintenance of a uniform angular velocity of the crank-shaft during a revolution. It follows from the nature of the motion of the crank and connecting-rod that this should be variable, and it can only be made uniform by the employment of a heavy revolving mass as the fly-wheel, or by coupling more than one engine to the same crank-shaft, the cranks being set at the angle giving the most uniform effect. In a pair of engines this angle is by no means the almost universal one of 90°, and as electric lighting engines are not required to reverse, there is no advantage in retaining that angle, and the most advantageous position should be determined for each particular engine, varying as it does with the speed, the grade of expansion, and the weight of the reciprocating parts. The reduced weight of the fly-wheel and the increased uniformity of motion thus attained are well worth the trouble of finding the correct angle. With regard to governing, we have two cases to consider, *i. e.*, we may have either a practically uniform load on the engine, or one liable to sudden and considerable increase or decrease. In the first case it is certainly advisable that the governor should actuate a throttle-valve, but in the second we have either to control the engine by an automatic expansion gear, or by the hand of a careful engine driver, who varies the supply of steam to the engine, either at the stop-valve or at the expansion gear. It is needless to say that when the variation is at all considerable the latter should be the plan adopted. Both the governors and the fly-wheels of steam-engines are employed to secure uniform rotation, the fly-wheel serving to equalize and reduce a constantly recurring and periodic irregularity, whereas the duty of the governor is to adjust the work done by the engine to the work to be performed, and thus prevent a continuous acceleration or retardation in speed. Sensitive governors have their value considerably reduced by insufficient steadiness in running, due to the use of too light fly-wheels. To secure runs of long duration we have to pay particular attention to the lubricating arrangements, allow ample bearing surfaces, and, what is perhaps more important than all, put in first-class workmanship. Arrangements should be made for lubricating the crank-pins when the engine is running. This matter presents no difficulty in vertical engines, or, again, in engines having overhung cranks, while for engines with double-throw crank-shafts the difficulty is not at all serious. All the other bearings about an engine of ordinary design present no special difficulties as regards lubrication. A considerable discretion should always be exercised as to the choice of a lubricant. The conditions upon which economy in working depends are so generally known that we need not enlarge upon them

1. *Mechanical World.*

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here further than to say that the conditions of electric lighting work are favorable to obtaining the best results, Many installations are now being laid down with the engines and dynamo machines in duplicate. This is certainly a safe although an expensive plan. In such arrangements the engines and machines should be worked alternately, as it usually happens when one engine is kept in reserve and not regularly worked that it is not ready when required.

A NEW STANDARD CELL.[1]

SINCE October last I have made some experiments on the zinc-alkali-copper oxide cell, with a view to determine the practicability of some modification of it.

The fact that copper and iron, and perhaps some other metals, dissolve in potassium (or sodium) hydrate when used as cathodes, suggested to me the possibility that the formation of the alkaline cuprate might occur at a definite and practically convenient difference of potential between the electrodes immersed in the alkaline bath. As a matter of fact, I find that a cell mounted with amalgamated zinc, potassic hydrate and metallic copper, gives, when charged until a blue color appears, a deflection of 170 divisions on the scale of a Thomson galvanometer; the Daniell, mounted with saturated zinc sulphate and copper sulphate, giving 156 divisions. The zinc-alkali-copper cell is joined by a double key to charging cells and to the galvanometer, a resistance of over 9,000 ohms being included in the circuit of the latter.

The proper shunt is, of course, employed. This deflection of 170 divisions seems to be invariable, and the cell experimented upon promises to be a desirable practical standard of electromotive force. Its excellence appears to consist in the fact that the cuprate produced breaks up before it diffuses to the amalgamated zinc, depositing oxide of copper, which settles. The zinc is suspended about an inch above the copper—which is a spiral ribbon, exposing about two square feet of surface—and the resistance is less than an ohm. I have used a 10-per-cent. solution of "depurated" potassic hydrate. After some trials it is found that the shifting of the cell from the charging source to the galvanometer circuit may be done leisurely, as the electromotive force does not seem to begin to fall off for some minutes. Further testing of the effect of changes of temperature, strength of solution, etc., is in progress. Thus far the temperature of the cell has been allowed to vary very little, not enough to affect the readings. I offer this preliminary note as of possible interest to your readers. This type of cell would be admirably adapted to furnish any desired multiple of its electromotive force.

F. C. VAN DYCK.

Rutgers College, New Brunswick, N. J., June 18.

ABSTRACTS AND EXTRACTS.

SAFETY OF ELECTRIC LIGHTING.

THERE are, without doubt, numerous cases in which the electric light can not only be used more economically than gas or oil—that is, with regard to the total amount of illumination given out—but where it is, in addition, possessed of a far more important quality, that of (comparatively) perfect safety. The most notable instance of this will occur at once to the reader's mind, since for use on board steamships, whether passenger or cargo boats, this form of illumination stands unequaled. There can be little or no doubt that the recent destruction by fire of the steamship "Maasdam" (caused, it is said, by a naked light being brought too near the cargo of petroleum oil), might, nay, would have been entirely averted, had only the vessel been provided with glow lamps, and the needful machinery for their maintenance. Apart, therefore, altogether from their superior lighting power and consequent greater comfort, the item of safety is a still stronger argument for their use in comparison with the often dangerous and always unpleasant oil lamps, which the public and those who live on the sea have for too long endured. We also note a recent installation of glow lamps in a large distillery, where constant care had previously been needful in the use of gas, by reason of the inflammable spirit fumes evolved during the process of distillation. For all such purposes, therefore, this method of lighting cannot be too highly recommended; and when, as we believe is the case in this instance, there is a clear monetary profit to be obtained by its use, one would be tempted to consider the tradesman or manufacturer extremely short-sighted in failing to avail himself of such advantages. In all manufactures where mineral oils are much used, in sugar refineries (for the vacuum pans, for example), in the majority of textile factories, and in countless other places of industry, we are convinced that electric lighting will be found to give the greatest benefits with the fewest risks. —*Mechanical World.*

LARGE OR SMALL DYNAMOS.

IN a work on the electrical transmission of power, M. Marcel Deprez and M. Japing state that a great many problems connected with this subject may be solved with the machines already constructed and the means actually at command, and also that the future is to large machines. Commenting on this, the *Bulletin International des Telephones* observes that electric lighting experiments in England and Austria with alternate-current machines do not appear to have settled the question. Edison with his continuous-current machines does not seem to have exceeded 40 or 50 h. p., a long way off 200 h. p.; and M. Marcel Deprez's experiments at Creil have special interest in this connection. Our contemporary, however, asks if, in every respect, large machines give comparatively better results than small. It is intended that the generating machines at Creil shall weigh from 35 to 40 tons for a current of 7,500 volts and 20 ampères, equal to 200 h. p. at starting. The receiving machines at Paris will weigh from seven to eight tons, and communicate to the shaft an available work of 30 to 35 h. p., whence it follows that the weight per h. p. will be about 175 kilograms (31-2 cwt.) for the generator, and 200 kilograms (nearly 4 cwt.) for the receivers, under the most favorable conditions. Now, in the present machines, such as the Gramme, for instance, the weight per h. p. does not attain 40 or 80 kilograms (rather over 7½ or 15 cwt.), according as they are used as generators or receivers. Therefore, the mean weight or matter per h. p. in large electrical machines will greatly exceed that of small machines. Here is a contradiction not generally met with. But, adds the *Bulletin*, this is not the first time that electricity quits beaten paths; and such small details will be no bar to ultimate success.

ELECTRIC LIGHTHOUSES.

SOME light is thrown on the important question of the availability of electricity as an illuminant for lighthouses in a recent paper reporting results of the French scientist M. Allard's experiments. In ordinarily clear atmospheric conditions it has been found that the light at Dunkirk, which is obtained from mineral oil and is of 6,250-candle power, is visible 32 miles, while an electric light of 125,000 candles is visible 46 miles. Thus an increase in the illuminating power of 20 times only increases the distance penetrated 13 miles, or 42 per cent. But in air of less than ordinary transparency the electric light can be seen only 2½ miles further than the mineral oil light—an increase of only 24 per cent. In very foggy weather the electric light penetrates but little over half a mile further than the oil light.

The electric light from this showing is not, after all, so very much better for lighthouse purposes than mineral oil,

1. *Science.*

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But it should be remembered that the cost of an electric light of 125,000 candles is, according to the computation of both French and English engineers, from four to six times less than that of an oil light of equal penetrative power. For this reason the electric light bids fair to become the future illuminant for all great lighthouses. If such lights as that of the new Eddystone, with its electric beam of 160,000 candles, or the electric Lizard, which has been seen by a ship seven miles distant in a fog, were more numerous on the sea coast the perils of the mariner would be greatly reduced.—*Manufacturers' Gazette.*

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents. Anonymous communications cannot be noticed.

The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.

In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.

Sketches and drawings for illustrations should be on separate pieces of paper.

All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

THE RAILWAY SIGNAL DECISION.

[35]—I have no commission to defend the Supreme Court; but think your recent editorial comments upon its decision in the electric signal case, are unduly alarming to the owners of inventions; and therefore I will venture to suggest a more cheerful interpretation than yours.

The Court decided nothing but a question of fact: decided only, that the Hall contrivance does not infringe the Pope patent. To support this conclusion the Court assigns two independent reasons.

1. Hall does not use the insulated sections of track which Pope uses for circuit-closers, and includes in each of the combinations covered by his respective claims.

Now such an omission has been fatal to any charge of infringement, of any combination claim, ever since the decision in Prouty *v.* Ruggles (16 Peters, 341), decided in 1842, unless the defendant used an equivalent for the element which he omitted. The Court found the Hall circuit-closer not to be an equivalent of the Pope circuit-closer, because it was not known at the date of the Pope patent. That such a fact is fatal to equivalency, was first declared by Justice Clifford in the case of The Union Sugar Refinery *v.* Matthieson (2 Fisher, 629), decided in November 1865; and was repeated by the same warm friend of patent-rights in the later cases of Seymour *v.* Osborne (11 Wallace, 556, 1870), Gould *v.* Rees (15 Wallace, 193), Gill *v.* Wells (22 Wallace, 31) and Imhauser *v.* Burk (101 U. S., 656, 1879). In all of these later cases, Justice Clifford spoke for the Supreme Court. The doctrine is one which I do not find it possible to like; but it is not a new doctrine, and, during all its twenty years of life, it has generally been quite a harmless one.

2. The combination of Hall differs from that of Pope in respect of mode of operation; because Pope's combination is so arranged that every circuit, when closed, differs in length, and therefore in resistance, from every other circuit when closed; whereas all of Hall's circuits are of precisely the same length and resistance To effect this improvement, Hall uses the earth for a third line conductor, and combines the two line conductors of Pope with each other, and with the earth, in a different way from that in which Pope combines his two line conductors together.

Now these differences of combination seem to me to be undeniable; and they seem also to be material, because they result in different modes of operation, having widely different degrees of utility. There never was a time, since the foundation of American patent law, when so wide a difference in mode of operation was not fatal to infringement. See Smith *v.* Downing (1 Fisher, 83, 1850) and Eames *v.* Cook (2 Fisher, 149, 1860.) A suit for infringement never could be sustained on a combination claim, where the defendant combined all of the elements of the patented combination, but combined them in a substantially different way. Gill *v.* Wells (22 Wallace, 14, 1874). Changing the relative positions of the parts of an apparatus averts infringement, if the change of position results in a substantially different mode of operation, even though the function of the apparatus remains the same. Brooks *v.* Fisk (15 Howard, 221, 1853).

The conclusion of the whole matter is that the youngest of the doctrines of law involved in the electric signal case is nearly twenty years old, and most of them are as old as the patent system itself. Had Justice Bradley or Justice Blatchford written the opinion, it would probably have been put into more familiar sentences and phrases; but the decision would have been the same, unless the writer had been authorized by the Court to depart from the precedents. ALBERT H. WALKER.

HARTFORD, Conn., June 6, 1885.

[It does not seem to us that Mr. Walker's letter exactly meets the point which we intended to make in our editorial of last month. He says:—"The Court found the Hall circuit-closer not to be an equivalent of the Pope circuit-closer *because it was not known at the date of the Pope patent.*" In Mr. Walker's very excellent *Text Book of the Patent Laws*, we find three tests of equivalency laid down. First, the equivalent device must perform the same function. There can be no question that the devices of Pope and Hall were the same in this respect, the function being the closing of an electric circuit by a moving railway train. Second, it must perform the function in substantially the same way, "not necessarily," says Mr. Walker, "a theoretical scientific sameness," but so nearly similar that the respective devices may be interchanged in the combinations, and still perform the required function "with a result that is beneficially the same." In the case under consideration the conditions require that the electric circuit shall be closed by or upon the passage of the train, and remain closed long enough for the signal to be brought into position, say three or four seconds. Pope's device accomplishes this, and so does Hall's, and these are only two of a large number of more or less similar devices, which are equally well adapted to the purpose and may be substituted for each other at will, without in the least affecting the result. Third, the device must have been known at the date of the patent. This brings us to the real point at issue. What is meant by being "known" at the date of the patent? Must the new element be something essentially novel, either in principle, structure or mode of operation, or need it be "new" only in the technical patent-office sense, that of being a trifling improvement, modification or equivalent of some detail of an existing device? In the present case, the circuit-closer employed by Hall was a contact-spring, which was made to press against a contact-point by the long arm of a lever, whenever the short arm of the same lever was depressed by the weight of a moving train. A retarding device was employed to prevent the too sudden recoil of the contact-spring. All this was familiarly known in the art, as the evidence in the case showed. But the particular construction of the retarding device which, in combination with the lever circuit-closer, was patented by Snow, after the date of Pope's patent, and which was used by Hall, involved nothing more than the substitution of an atmospheric dash-pot, consisting of a piston moving within a cylinder, for the bellows or the equivalent clock-train and fan which had been used in prior circuit-closers. The cylinder and piston, technically speaking, was doubtless enough of an improvement over the bellows and other like devices to support a limited patent, although it was in itself a familiar form of retarding device; but it seems to us that to hold this minor improvement in an accessory device appertaining to a known form of circuit-closer, to be sufficient to constitute the entire circuit-closer an element "not known at the date of the patent," and to argue therefrom that an otherwise novel combination is not infringed when it is used, is an entirely new doctrine in patent law, and one likely to lead to momentous consequences. If the mode of operation, or the result sought to be attained, were in the least affected by the change, there might be some reason to suspect that there was an element of novelty in the circuit-closer, but we do not understand that it is pretended that such is the case.

Mr. Walker, following the opinion of the Court, contends "that the combination of Hall differs from that of Pope in mode of operation, because Pope's combination is so arranged that every circuit when closed differs in length, and therefore in resistance, from every other circuit; whereas all of Hall's circuits are of precisely the same length and resistance," and adds:—"These differences of combination seem to me to be undeniable, and they seem also to be material, because they result in different modes of operation, having widely different degrees of utility." Why are they material? The equalization of the resistances is no part of Pope's invention, and is not even mentioned in the claims of his patent. Professor Moses G. Farmer, the complainant's expert, testified, without contradiction, that it was not at all essential to the operation of Pope's invention that the resistances should be equalized; and, moreover, it was in evidence that a certain signal

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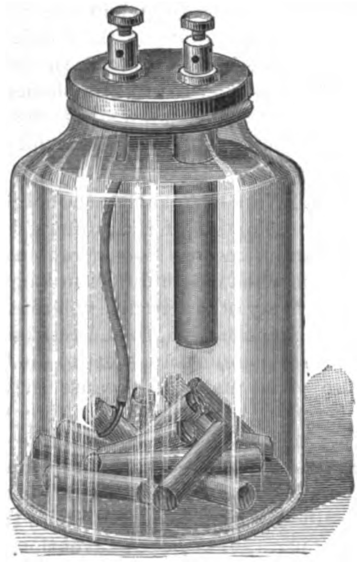
plant was in actual and successful operation with unequalized resistances. It was also proved that the very system of equalizing circuits employed by Hall was first made known by Pope, in a publication issued in 1869, and that Hall had chosen to apply it to his signals as one method out of several which he might have used, all public property and all equally well known. Hall's expert, Professor Morton, himself testified that the equalization of the circuits in conjunction with Pope's method was within the common knowledge of any skilled person, and required no invention whatever to apply. Suppose Pope had said in his specification:—"The circuits should be made of very large iron wire, as their resistance will thereby be reduced and the operation of the mechanism facilitated," and Hall had discovered that a smaller, instead of a larger wire could have been used with like advantage, provided it was made of copper, which is a better conductor than iron. Would that have avoided the patent? Certainly it would, according to the reasoning of the Supreme Court and of Mr. Walker.

The new result which was accomplished by Pope was the actuating of many widely separated signals from a single battery. To effect this result the only essential requirement was the extension of two conductors from the battery along the track, so that a circuit which should include the particular signal required and this common battery could be completed at any required point. What was patented was the least number of indispensable elements in combination by which this result could be effected. What was described was "the best mode in which the patentee has contemplated applying that principle," as required by statute. But the Supreme Court now says that a difference in the particular well-known means selected by the defendant to carry out a certain detail of practical application, not claimed as a part of the complainant's invention, and in no wise essential to its beneficial operation (inasmuch as it may be, and has been, omitted altogether), constitutes it a different invention.

Mr. Walker says:—"There never was a time since the foundation of the patent law when so wide a difference in the mode of operation was not fatal to infringement." We must confess ourselves unable to see any difference whatever in the "mode of operation." The mode of operation is the closing at different points on a railroad of the circuit of a common battery, so as to traverse the electro-magnet of a particular signal. What has the resistance of the circuit to do with the "mode of operation," unless it in some way affects the result? What has the equality of the different circuits to do with the "mode of operation," unless an inequality would *necessarily* affect the result? If it has nothing to do with it, what becomes of the "substantial difference" in the mode of operation referred to by Mr. Walker?—EDITOR.]

A CHEAP AND EFFECTIVE BATTERY.

[36]—A cheap, simple and efficient battery, suitable for the use of experimenters and amateurs, has long been needed. I have worked on the problem myself for several years, and have obtained very satisfactory results from one constructed as follows:—



Take an ordinary glass fruit-jar, fitted with a cover of wood or hard rubber, and place in it a number of pieces of electric light carbons, hundreds of which can be picked up in the streets every morning after the lamps have been trimmed. The connection between the carbons and the binding-screw on the top of the cover is best made with a gutta-percha covered wire, having its lower end bared and wound tightly round and secured to one of the carbons, thus making a connection with all the other pieces in contact with it. A piece of amalgamated zinc of any convenient size or form is suspended within the jar, from the wooden cover, and has a binding-screw attached to it.

The jar should be filled about two-thirds full with dilute sulphuric acid or other suitable solution. I find that the electropoion fluid or bichromate solution does very well.

I hope you will find room to publish this, as I think it will be of use to many amateurs. The whole battery complete can be made for about 20 cents, and it will give a good current on a closed circuit for a long time. I now use this battery in preference to all others. C. E. MEILLORET.

13 Fifth street, Brooklyn, E. D.

CONSUMPTION OF COAL BY STATIONARY ENGINES.

[37]—In the May number of the present volume, the article entitled Electric Motors on the Elevated Roads—Corrected Figures, Mr. Curtis in speaking of the amount of coal required by stationary engines states that 2.25 or even 2.50 lbs. of coal per h. p. hour is an extreme figure, and that 1.75 lbs., the amount given by Prof. Farmer, could not be counted upon. The writer upon making inquiries, obtained from the Corliss Steam Engine Co. a few figures which may be of interest to your readers and which conflict somewhat with Mr. Curtis's statement. Concerning their compound condensing pumping engine at Pawtucket, R. I., they say that "taking into calculation *all* the coal used in starting, banking fires and pumping, and no deductions made for ashes or clinkers the consumption of fuel per h. p. hour was 1.66 lbs. for the whole year of 1883."

"A similar engine at Petoconsett which supplies the water for Providence, calculated on the same basis for the same year, was 1.68 lbs."

"Our compound mill engine (tandem) at Nourse Mill, Woonsocket, R. I., gave on a seven days trial on *same basis* 1.62 lbs. of fuel per h. p. hour driving 500 h. p." A. J. NEWELL.

HOLYOKE, Mass., June 17, 1885.

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CORRESPONDENCE.

NEW YORK AND VICINITY.

Shall Liberty Light New York Harbor?—Profits of the Gas Companies.—The Lalande-Spence Battery Exhibits.—Plans of the U. S. Signal Bureau.—The Western Union Company Institutes a Libel Suit.—Change in the Firm Name of L. G. Tillotson & Co.—The Southern Joins the Mutual Union Lines.—New Yorkers Visit the Hathaway Printer at Philadelphia.—A New Electric Lighting Station.

THE Bartholdi statue having actually arrived, its erection in the harbor at an early day will afford an excellent opportunity for our western friends to tell what they can do in tower-lighting. As there will be no trees to interfere, according to their theory, New York bay ought to be well lighted by sufficiently powerful lamps placed in Liberty's crown. As the advertisement will be one of the most valuable identified with this great work, second only, perhaps, to that obtained by the eminent sculptor and the enterprising *World*, the bids for the installation will doubtless be very low.

According to published reports, the gas companies are standing up very well under electrical competition. The Mutual leads off with an average net profit for the past year of over $1 per 1,000 feet. The net profits of the other companies per 1,000 feet

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were as follows: Municipal, $1.02; Knickerbocker, 96c.; Metropolitan, 85c.; Manhattan, 82c.; New York, 72c.; and the Harlem, 45c.

A very interesting exhibition of the Lalande-Spence primary battery is being given at 15 William street, by Mr. Hugh A. Fergusson. This battery has attracted much attention from high scientific authorities in England. It is contained in an iron cell. Against one side is placed an iron grid, the interstices of which are pressed full of oxide of copper. The negative pole is formed of two zinc plates in the centre of the cell, the whole being excited by a single fluid—a solution of caustic soda. The electromotive force is low, as is also the internal resistance of the battery. There is no local action, and the solution, when drawn off, may be treated with carbonic acid gas, precipitating oxide of zinc, a regular article of commerce. This, together with the metallic copper deposited, is said to practically cover the cost of maintenance. Having had no opportunity to verify the statements made in regard to its constancy, we can only say that it is worthy of critical examination. It is the intention to introduce it for domestic electric lighting and motor purposes.

About the 1st of July the U. S. Signal office in this city will introduce a more elaborate system for the display of signals, indicating at all times the latest forecast of the weather. At present flags and lamps are hoisted only in the event of some radical change which is of interest to farmers, mariners and hotel-keepers.

The red flag, with a black centre, is the cautionary storm signal, indicating the approach of at least a 25-mile wind.

A white flag, with a black centre, hoisted above the red, indicates a dangerous "off-shore" wind from the northwest. The same flag hoisted by itself signifies the approach of a cold wave. It is at present somewhat out of practice.

A statement was made in the *Wall Street Daily News* a few weeks since to the effect that the Western Union Telegraph Co. was not earning its dividends. President Green, on behalf of the company, brought suit for libel against Charles D. Keep, editor and proprietor of the *News*. Counsel for the defense intimated that the statement was made in the interest of independent journalism, and that the conflict was inevitable. Notwithstanding all reports of this character, it must be admitted that the Western Union company not only pays its dividends, but its employés and its bills. In fact, it meets all its obligations, and in this respect, at least, has for many years maintained a good financial standing.

The old firm name of L. G. Tillotson & Co., so familiar to all electrical people, is now to be superseded by the title of E. S. Greeley & Co. Practically there will be no change, as the business methods, factories, sales-rooms and offices will remain as heretofore. It will be a long time, however, before the name of Tillotson will be forgotten in connection with the traffic in electrical goods.

The business alliance between the Southern and the Mutual Union Telegraph companies, which was made a month ago, was a very shrewd piece of work. The Southern company's connection was a very important link in the opposition telegraph system, and furnished quite an important share of the Commercial Cable company's traffic.

Quite a delegation of gentlemen from this city visited Philadelphia on June 8th, to inspect the Hathaway printing telegraph system, which has been extensively boomed by the daily press. No name appears of any electrical expert who has yet examined this machine, so that the most that can be learned regarding it is, that some gentleman sat down to a key-board and transmitted despatches with a speed and accuracy that would have astonished the ordinary operator on any of the old systems. Although it was announced that no stock is for sale in this wonderful enterprise, one or two gentlemen in this city have succeeded in getting into the syndicate. It is said that the assets of some of our most conservative capitalists, embrace a fair sprinkling of Keely motor, and similar questionable investments, popularly known on the street as "cats and dogs." Very likely, now that there is a plethora of idle capital, a few individuals may be found who are willing to go it blind in ventures of this description.

The United States Illuminating Co. is constructing a new central station at the foot of 29th street, East river. It is to supersede the 44th street station which must be removed to make way for a new street to be cut through. The new station will utilize 1400 h. p. to be furnished by compound engines, and its capacity will exceed that of the present Stanton street station.

NEW YORK, June 20, 1885.

CHICAGO.

Underground Work in Earnest.—The Streets in a Chaotic Condition.—Satisfactory Experience with the Dorsett Conduit.—Another New Insulating Compound.—How Quotations Have Been Stolen from the Board of Trade.—Western Legislation Against Telephone and Telegraph Interests.—Tales of Bribery and Corruption.—The Great Electric Storm of June 2.—Little Doing in Electric Lighting.

FOR the past few weeks our streets have been in a fearful state of unrest and blockade. The heart of the city has been all "tore up" in the interests of the gas, sewer, water and wire undertakers and sextons. Much the larger portion of the mournful ceremonies have pertained to the work of the underground conduit people, who are literally threading the business part of the city with their conduits for electric light, telegraph and telephone wires. The company which is doing this work is the Chicago Electric Sectional Underground Co., or, as they used to say in patents, "its equivalent, substantially, as hereinbefore set forth." Professor Elisha Gray is the head and president of the company, and the system adopted is that of Mr. D. H. Dorsett, of this city. The material used is a concrete of asphaltum, pressed in sections, containing from seven to 17 longitudinal holes. These sections are molded with a flange at one extremity, so that, on being laid, a joint can be made air, water and gas-tight, by means of the similar material to the body of the conduit, applied hot. By this arrangement the placing of the pipes is readily done, and perfectly finished with a minimum of labor. In talking with the professor, I learned that several of the objections which have been urged against the manufactured material are thoroughly groundless. Neither moisture nor acids have any effect upon the material, and this statement is based upon experiments actually made, for instance, in a mixture of sulphuric acid and water, 50 per cent. of each being used, a block of the concrete was soaked for 30 hours, yet, afterward, with 150 cells of battery and a delicate galvanometer, not a trace of conductivity was shown, and no evidence visible of attack by the acid. It has been assumed also that, from the nature of the compound, it would be liable to breakage by pressure, if, from any cause, the bed upon which it rests were to become uneven from settling, or other causes. An unexpected but very gratifying test of its power to resist crushing strains was made the other day on Dearborn street. A change in the programme of the street authorities altered the grade between two streets, and brought the diagonal pipes, which run from the man-hole to each of the four sections of the block bounded by the street and alley, about four inches above the surface. While these were thus exposed, a street roller was set to work tamping down the substructure of broken stone. Back and forth, crashing over these pipes, that roller went during much of the day, and it was presumed every section would be ruined. Only two joints were loosened out of some 60, and no section was broken. One point more: a section of this conduit which runs to the Grannis block ruins, being about to be used again for electric light wires, was tested a few days since in a rather crucial manner. Naked wires were drawn through two tubes in the conduit for a distance of more than half the square between Washington and Madison. With a battery of 20 cells of chloride of silver, a Wheatstone bridge, and a delicate galvanometer, the insulation proved far above the capacity of the apparatus. Joining the two wires at the farther extremity could not reduce the deflection of the needle.

Another candidate for patronage from wire people has lately come to the front in a novel form. In this system the insulating material—the composition of which is a profound secret for the present—is in a plastic condition, and remains so thus far since the first experiments. It is assumed that it will continue in this condition for years. This material is poured into a wooden box, into which the naked wires are laid, and although these may be within a very short distance of each other, the insulation resistance is shown to be 'way up in the millions. Placing these wires on glass or porcelain insulation to keep the natural sag from making contact at the bottom or sides of the box, will leave them in excellent insulation, and wires can thus be placed underground at a minimum expense, as the material, or "mixture," as the inventor calls it, costs less than any material for such purposes within the knowledge of the writer, is easily obtained, exhaustless and readily compounded.

We have had plenty of amusement hereaway out of the Board of Trade fight with the bucket shops. The former has been puzzled immensely in endeavoring to discover ways and means of preventing the leaks which have been constant during the interim since the quotations were cut off. There is no equivalent for galvanometers in this sort of search, and even shutting out visitors from the open gallery of the board did not stop the waste. The board became desperate, and it was to an extent a matter of self-defense on the part of the members that the guilty party should be caught at all hazards. Many a member, while apparently paying strictest attention to transactions, was in reality watching some suspected individual, in the hope of detecting the guilty party. Weeks of this self-constituted detective work has been going on, but until Saturday last all had gone for naught. On that day one of the officers of the institution discovered, near a window from whence the open board was plainly visible, one whose movements were so uniform as to rivet the attention of the officer. Once on the right track, it required only a little time to get at the whole scheme. At every change in the market, a hand, "right or left, as the case may be," as the old tactics had it, went up to the hat or the cheek. Knowing the interpretation, it is easy to read almost any puzzle. Investigation showed a hole in a curtain at the open board room, but the owner of the eagle eye which had been receiving the surreptitious information saw the commotion which followed the discovery, and disappeared

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from his hiding place before the board authorities could reach him. It remains to be seen whether this is the last leak, or whether there are other weak spots to ferret out and close up.

Our State Legislature is struggling to put clothes-pins on the noses of the telephone and telegraph companies in the way of regulating them in the matter of taxes and rentals. Up to date the matter has not looked as if it would be reached the present session, as the proposed new election law, in which there is much pro and con of politics, by the way, is the subject of so much wrangling, it is doubtful if these bills, of which there are several, will, any of them, stand much of a chance of becoming a law this year, unless there is an extra session of the Legislature. There has been some entertainment also, arising out of charges of corruption or bribery, or some such merchandising, among the members. A committee of investigation has made a visit to Chicago, but it looks as if they came at an inopportune time. Somehow it happened that the parties whom they desired to interview were out of town. Visiting their mothers, gone a-fishing, or otherwise engaged, so that, like Mrs. Hubbard's dog, they found that—

"When they got there,
The cupboard was bare."

The Ohio Legislature took hold of the matter in a very proper and sensible manner. The bill was placed in the hands of a committee for investigation, who reported it back adversely, having ascertained that the hue and cry about exorbitant rentals did not come from those who pay for telephone service, but from outsiders who have no interest whatever in the question, save from the standpoint of the communist, who believes in a weekly division of this world's goods, provided no one has less than he. In Michigan the bill was strangled by a vote in the House of 43 to 23.

A series of electrical phenomena were visible here on the 2d of June, which were interesting and peculiar. Throughout the early part of the day it was evident from indications that the elements were arranging for a grand fête at the celestial Bois de Bologne, possibly, or a grand display of nature's forces in honor of the near completion of "Brer' Toldi's Liberty frightenin' de worl'," perhaps.

The telephones took up the alarm first, and hissed and sputtered and fried like so many broilers and pans at a fish picnic, or a Friday church festival. The air and the earth seemed charged in every direction. The heavens were coursed by messengers in hot haste, marshaling the hosts of battle and arranging the programme of salutes, distributing the artillery ammunition, and inspecting the ordnance. Towards evening it became apparent that the preliminaries were perfected, and a dead calm succeeded the hurried preparations. Then the curtain—a dense black cloud—rolled up from the west, darkening the heavens as by a bit of stage strategy, to show by contrast the intense illumination to follow. A few preliminary flashes and signal guns, following rapidly as a cue to the wind and rain, were immediately succeeded by a few scattering skirmish drops, a puff of air, and, in less time than is required to chronicle the fact, the rain fell in sheets, accompanied by a terrific wind. Grand salvos of celestial discharges accompanied these, and the entire heavens were illuminated in every direction. The wind, in the course of a few minutes, rose from three to 26 miles per hour, and as suddenly slowed up to a six-mile rate. The temperature also enacted the rôle of star in the exhibition. The mercury fell in 11 minutes after the first burst of the storm, as many degrees. The wind completely boxed the compass. Fifty-four one-hundredths of an inch of water fell in 43 minutes. A peculiarity of the electrical portion of the storm was the persistent discharges in a vertical direction. There seemed to be no evidences of difference of potential save between the earth and clouds. In many instances discharges were repeated in precisely the same line, as far as could be judged, and with no apparent variation of zig-zag deflections, these bolts occurring in several instances in rapid succession—at one time three in as many seconds. To the west these evidently struck the prairie, while to the east the lake was the favored recipient. Within a compass of a few miles around the city, trees and spires were struck, and one or two small conflagrations occurred, but without material damage.

At Highland Park, 23 miles north, the principal hotel was singled out as a mark, and the rod over the cupola received a heavy bolt. Those who chanced to be looking in that direction at the instant witnessed a beautiful exhibition of nature's powers. The entire rod seemed enveloped by an inverted cone of phosphorescent light, which extended downward below the roof of the structure. The charge was partly dissipated through the pipes of the building, and played many harmless freaks in its skipping from point to point, cracking and spitting like minor fireworks in its endeavors to reach the earth. An employé of the house had a cold-chisel ruthlessly snatched from his hand, and thrown across the room.

Within the city we were not so fortunate. Several parties lost their lives from direct bolts, while others in the immediate vicinity felt severe shocks. Two men who were pushing a hand-car in a lumber yard were killed instantly, and, falling, immediately rebounded and turned completely over before striking the earth again. The telegraph people suffered only from the twisting up of their wires—the city wires were comparatively unharmed; but the telephone inspectors had their hands full, exchanging burned for new coils throughout the city, but principally in the southern and southwestern portion of the corporation.

The disturbed elements took a rest after the matinee, which opened about 4:30, and repeated the performance in a milder form during the latter part of the evening.

Lynch & Banta, telephone and telegraph stock-brokers, have dissolved partnership. Colonel Lynch will continue in the same line of business at the office of the late firm, 144 Lasalle street. Colonel Lynch is well known to the electrical fraternity—an operator in the days of telegraphic babyhood, a colonel in the war of the rebellion, detailed for telegraphic duty, secretary of the A. D. T. Co. here; then holding the similar position with the Western Electric Co., he finally went into the business which he is now engaged in, and purposes continuing.

The electric light business is rather dull than otherwise just now, only a few plants going in, and many of these of a temporary or experimental character. It is probable that, by the time you receive the next batch of items from here, something worth while will have developed.

CHICAGO, June 15, 1885.

BOSTON.

New England Weather Prophets to Assist the Signal Bureau.—Economical Tendency of the New England Telephone Co.—Decision in an Electric Gas Lighting Suit.—The Telephone Conference.—Legislative Telegraph Regulation.

THE New England Meteorological Society, of Cambridge, is coöperating with the United States Signal Service for the display of authorized signal flags indicating the weather forecasts made by the service for the New England states. Special indications are prepared at 1 o'clock A. M. each day and telegraphed to Boston and New London for distribution, and by the coöperation of the telephone, time and railroad companies, these telegrams are repeated to all parties authorized to display the official flags in the various towns and country places. Within a short time over 300 different persons in various places have made application to be so authorized. Mr. J. N. Keller, general manager of the New England Telephone and Telegraph Co., has issued an order to the effect that when the weather indications are received at any one of the central exchanges of his company, they will be furnished free, once each day, to one person, to be designated by the Meteorological Society, at any place that can be reached by telephonic communication, and which may be located within the boundary of such central exchange.

The Standard Time and Electric Co., of New Haven, will coöperate with the Southern New England Telephone Co. for the same purpose.

Mr. Davis, the secretary of the New England Meteorological Society, furnishes information to those desiring to become local weather prophets about signal flags, where to obtain them, etc. All correspondence concerning local signals in Connecticut should be addressed to J. H. Sherman, Signal Office, New Haven.

At the present time the Boston exchange sends weather forecasts to Dedham, Canton, Waltham and Medford. This system will be of great benefit to farmers and others interested in agricultural matters, and it is hoped that good parties may be obtained in all places, who will not "get tired" too soon.

The executive committee of the New England Telephone Co. recently held a very important meeting in this city, at which they took the first steps toward the adoption of a more economical policy in the administration of the company's affairs. The action taken will reduce the company's operating expenses over $10,000 per annum, and the other measures now pending will bring them down still further. Among other things, it was voted yesterday to abolish the office of regular attorney, to which a salary of $3,000 per annum is attached. It was voted to abolish the salary of $6,000 per annum paid to vice-president Ingham. The resignation of A. C. Sanborn, superintendent of the Lowell division, was accepted, and it was practically decided not to fill the vacancy. The committee also discussed a plan of reorganization, which will effect a consolidation of all exchanges in the matter of management, and make a large saving in running expenses. The cutting off of many of the employés who can be spared without injury to the company's business, and a general "doubling up" of service, is also among the changes under consideration. The construction work is being kept within the closest possible limits, and it is intended, in short, to do everything that can be done consistently to bring the operating cost down to a basis that will admit of a profit sufficient to give the uneasy and dissatisfied stockholders a good dividend.

Judge Colt, of the United States Circuit Court, on the 20th ult. gave an opinion in the cases of the Boston Electric Co. *v.* the Electric Gas Lighting Co. and the New England Electric Manufacturing Co., sustaining the defendants' plea as to the jurisdiction of the court. The defendant corporations were organized under the laws of Maine, and sued in the Circuit Court for the

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district of Massachusetts. The writs were served by attachments of corporate property within this state, and by service upon the proper officers here, if such service could be legally made. It was agreed that the defendant corporations have a usual and principal place of business in Boston. The opinion decides that Courts of the United States cannot acquire jurisdiction by an attachment of property merely, but that there must be a personal service of the writ or process upon the defendant, or a voluntary appearance. A corporation, says Judge Colt, cannot be sued in a foreign state, because it carries on business there, in the absence of a state law authorizing such suit. This decision overrules the opinion of Judge Lowell in Hayden *v.* Androscoggin Mills, who held that a foreign trading corporation doing business in the State of Massachusetts may be sued in the Circuit Court by summons duly served upon an officer of the company, the fact of the attachment being immaterial. "We cannot adopt this view," says the opinion, "in the light of what we believe to be the great weight of authority on this question."

The most interesting feature of the month has been the gathering of invited telephone guests at Boston's famous hotel—The Vendome. Including the gentlemen connected with the office of the American Bell Telephone Co., in this city, the total attendance was not far from 75 in all. They literally came from the four points of the compass, and were a fine body of men, representing, as they did, the bone and sinew of the telephone interests in the United States. The proceedings were "strictly private," but the "visiting statesmen" were ready to talk about what had been done, that is, about *most all* that had been said and done. The general business, prospects, etc., as well as practical mechanism, bells, apparatus of all kinds, cables, under and overground, came up for an interchange of opinion and experience. The meeting was formally opened June 8, in the afternoon, being called to order by Col. Forbes, the president of the American Bell Telephone Co., Mr. C. H. Haskins being made chairman, and Mr. E. J. Hall, Jr., secretary. The meetings were interesting and instructive in a high degree, and probably as much solid good information was carried away by each delegate as is usually in the telephone conventions heretofore held. This convention would seem in some measure to forestall the business of the National Telephone Convention, and also a large share of the fun. After the serious business of the delegates had been attended to, an enjoyable visit was made to the elegant offices of the Boston Telephone Exchange, then to Mr. Ezra T. Gilliland's "mechanical department," where the company were shown the new "village telephone system," recently patented and worked out by Mr. Gilliland in his own ingenious and perfect manner. This is an arrangement of apparatus whereby a limited number of subscribers in a small community can call each other and converse without the intervention of an operator or central office. The apparatus is simple and can be easily operated. Many of the telephone men predicted it a success. Carriages were furnished by the American Bell company, and a drive was taken through Boston's superb suburbs, said to be, as are all of Boston's institutions, unrivaled. On Thursday, accompanied by the directors and management of the parent company, a short sail was made in a steamer to Point Shirley, where connection was made with Taft's famous hotel, at which place they sat down to an elegant dinner. The guests are prepared to state that, with all her faults, the "old 'un" knows how to "treat" when her time comes. Friday was passed at the militia muster held in Framingham. Altogether, the affair was a success; the concessions made by the American Bell Telephone Co. to their licensees were announced early in the stage of the proceedings, and were received with satisfaction.

One of the pleasant incidents of the telephone conference, if not *the* pleasant one, was the action taken by the visiting delegates to show their appreciation of the hospitalities shown them. On Saturday morning when the officers and employés of the American Bell Telephone Co. appeared at their offices to perform the daily task, they found their desks and tables covered with beautiful and choice flowers, some in elegant designs, pillows, wreaths, crosses, etc., and the "waste places" made glad with loose flowers, strewn upon the desks. Business could not of course go on under such circumstances, and some time was spent in visiting each others rooms to inspect their several glories. Altogether it was a most delicate and beautiful act, and was much appreciated by the recipients.

The legislature are about through with telegraphic and electric matters of all sorts. In the Senate the following bill to secure greater care in the transmission of telegraphic messages was engrossed, with amendments, to read as follows:—

All persons, associations and corporations engaged in the business of transmitting or receiving telegraphic messages for hire shall be liable and responsible to the amount of $100 in any case for all damages caused by their negligence, or that of their servants or agents, in transmitting, receiving or delivering such messages, notwithstanding any contract, oral or written, to the contrary. No action for the recovery of such damages shall be maintained unless a claim therefor is presented in writing to such person, association or corporation, or to some officer or agent thereof, within 30 days from the time when such right of action accrues. The provisions of this act shall not apply to any negligence occurring in a telegraph office established for the convenience and safety of a railroad corporation in the running of its trains, and transacting a public telegraph business only as incidental thereto.

BOSTON, June 19, 1885.

PHILADELPHIA.

Mayor Smith's Reasons for Vetoing Overhead Line Privileges.—Amendment of the Legislative Underground Bill.—Poles to be Cut Down January 1.—The Firemen Retarded in Their Work by Wires.—Business of the Clay Commercial Telephone Co. at a Standstill.—The "Novelties" Exhibition.—Suit Against the American Rapid.

DURING the early part of this month Mayor Smith sent to Councils the following veto message, which was sustained by Select Council. In the lower branch a new bill was introduced, which meets the Mayor's objections:

GENTLEMEN:—I beg to return, without my approval, "An ordinance granting the Thomson-Houston Electric Light Co. permission to extend its lines by placing poles and wires on Girard avenue, Fairmount avenue, and on Spring Garden street."

The general reasons for the non-approval of the bill are as follows:

Under the ordinance approved June 13, 1882, Councils declared "that it shall be unlawful, on and after January 1, 1885, to erect or maintain any poles and wires for telegraph, telephone or electric light purposes, in the streets of the city of Philadelphia.

While willing to concede that it may not be wise nor reasonable to exact any such far-reaching action, it is beyond doubt, both to the interest of the city and the benefit of her citizens, that due care and precaution be given them in the preservation of their lives and property, and no description of the overhead system of poles and wires is so absolutely dangerous as the system of electric lighting.

Desiring to afford the present corporation an opportunity to avail itself of such privileges as your honorable bodies may deem wise, I would most respectfully suggest the following modification in the ordinance, which will make it more acceptable, namely:

The omission of the service from Second to Sixth streets, upon Girard avenue. A line of wires being already constructed upon each side of the street within this boundary, it can readily be admitted that the existence of another separate and distinct line upon either side of this thoroughfare would be most unwise and obnoxious.

Provision should also be made whereby companies or corporations securing such privileges from the city should be required to furnish city lights at the figures determined upon for compensation for this service, and not avail themselves of a public privilege to exact (as has been attempted by some of the companies) a charge greatly in excess of that paid other equally serviceable and reputable competitors.

Councils have likewise enacted in section 9 of the ordinance of March 30, 1882, "Regulating the introduction and providing for the charges for underground, overground, or overhead wires," that a bond shall be filed of record conditioned that all corporations, firms, or persons will comply with the provisions of this ordinance and of all other ordinances now in force or hereafter to be passed. This company have not been required, nor have they filed any such bond as is contemplated in the ordinance quoted.

Another decided objection to the ordinance is the fact that there is nothing either in the title or body of the ordinance to define or limit the privileges granted. Whilst it may be affirmed that electric lighting is the actual scope and intention of the company, the ordinance is so general, and entirely without any specific utterances of its intentions and desires, as to warrant in asking that its purpose and functions be clearly and plainly defined.

The desire to aid the city in properly policing the property of her citizens, which is much improved and aided by the introduction of an ample and good system of lighting the highways, will warrant my approval of this ordinance, if your honorable bodies may admit, after consideration, the wisdom of some of the suggested modifications; but I must clearly and unequivocally express the belief that, from and after the present time, the executive position will best advance the welfare of our city, and protect and guard the lives of her citizens, and especially those who are officially compelled to brave the dangers incident to fire and its consequent risks, by the disapproval of all future legislation which will add to either the extension or perpetuation of the unsightly and dangerous electric services which incumber our streets.

Very respectfully yours, WM. B. SMITH, *Mayor*.

At Harrisburg, on June 3, the underground wire bill was amended by the committee on corporations to suit the opponents. John R. Read and M. E. Olmstead represented the Western Union Telegraph Co., and T. B. Hughes, of Philadelphia, the Philadelphia telephone interests. An unsuccessful effort was made to strike out the clause prohibiting ground to be broken for the purpose of burying wires from May 15 to October 15. The failure to incorporate this amendment in this bill will render it of very little value, as by ordinance ground is not allowed to be broken in Philadelphia and Pittsburg in December, January and February. The opponents of the bill failed to have inserted a clause for reimbursement for losses sustained in being compelled to bury wires, but they had the following amendments inserted:

That no more than one fourth of the entire plant of any company or city shall be required to be removed or placed underground in one year: that no company shall be required to remove its wires from poles or housetops, or place the same underground in any street in which, or in connection with which, Councils have heretofore passed an ordinance or ordinances giving underground privileges, which are or may be exclusive, until such ordinance or ordinances shall be repealed; that no such ordinance shall be passed which shall not apply to all companies alike, within the municipality, where applicable, which own, control or operate telegraphic, telephone, electric light, or other wires, or a cable, on what are known as telegraph poles.

The bill was reported as amended. Its supporters will probably allow it to pass in its present shape for fear that its amendment might endanger its enactment into law. Its passage, they say, will at least be a recognition of the demand for the burying of wires.

In Common Council, Mr. Vanderslice called up the resolution of Select Council for concurrence, which provided that all telegraph and telephone companies be notified to remove their wires in the district bounded by Vine and South streets and the Delaware and Schuylkill rivers, by the 1st of January, 1886. In case the companies neglect to carry out the provisions of this resolution, the superintendent of the electrical department is to cut the poles and wires. An acrimonious debate ensued upon the resolution, and an attempt was made to recommit it. This was defeated

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by a vote of nine yeas to 48 nays. The resolution was then adopted by a *viva voce* vote. It had previously been adopted by Select Council.

In his report to the board of fire commissioners, the other day, chief-engineer Cantlin took occasion to refer to the recent destructive fire at the southwest corner of Second and Market streets. He said the greatest drawback experienced by the firemen in fighting the flames was the network of telegraph wires on both sides of the building. These prevented the use of the ladders in the early stage of the fire. The poor wires are catching it from all directions, but it will be a rather expensive funeral when the time comes to bury them.

Pending the judge's decision in the Bell Telephone suit against the Clay Commercial company for infringement of patents, the latter company's business is at a standstill. The case has been argued pro and con, but the judges seem in no particular haste to decide the matter. Meantime the Clay Commercial keep their main office open, but I understand that all hands connected with the concern might as well commence to take their summer vacations, and it is quite likely that they will be able to extend them far into the winter.

Rules have been formulated for the Novelties exhibition, to be held in the fall, under the direction of the Franklin Institute. The building at Thirty-second and Lancaster avenue will be opened for the reception of exhibits on Monday, August 24, and continue open for that purpose until Saturday, September 12. On Tuesday, September 15, the exhibition will be formally opened to the public, at 12 o'clock M., and continue open daily (Sunday excepted) from 10 A. M. to 10 P. M., until Saturday, October 31, 1885.

The case of Wm. B. Gill & Co. against The American Rapid Telegraph Co., of Connecticut, brought to recover $12,447.43 and interest, for work claimed to have been performed in constructing a telegraph line from Philadelphia to Pittsburg, resulted in a voluntary nonsuit yesterday.

PHILADELPHIA, June 17, 1885.

WASHINGTON.

Effectual Injunctions Against Pole Lines.—Wire Legislation Becoming Obnoxiously Effective.—The Washington Monument a Target for Lightning.—Taking in the Southern Telegraph Co.—Wires to be Cut Off the Treasury and White House, July 1.—The Legal Rights of the Small Boy.

LEGAL proceedings have been the feature in electrical matters here during the current month. In my last I mentioned that the Western Union company was replacing its air lines in the central part of the city with a pump-log cable line and thence through Seventh street to the boundary by a heavy pole line. When they had about half finished the laying of the pump-logs to receive the cable and had made equal progress with the pole line, certain citizens along the latter route sought and obtained an injunction restraining the company from erecting their poles and ordering those already up to be removed. Judge Hagner who heard the case, was once president of a telegraph company with a 20 mile line between Annapolis and Annapolis junction, and is therefore an expert on electrical matters. He declares there are no obstacles in the way of underground wires. This settles the matter notwithstanding the opinion of Judge Black, of Pennsylvania, in a similar case, he holding that the question had not passed the stage of experiment. But then Judge Black had not manipulated 20 miles of wire. Judge Hagner further held that the district commissioners had not been given such control of the streets as would warrant them in surrendering any part of their use to private individuals or corporations. The case was appealed to the court in *banc* to be heard by all the judges, at some time in the indefinite future. Meanwhile the pump-logs as far as laid await the cables and the Western Union sends its messages over the 10 or 12 miles of poles in the heart of the city, that would have come down had the mile or less on Seventh street, been constructed. The Telephone company is doing a large amount of underground work. To reach their patrons they put up a pole in the alley as near the centre of each square as possible. To this they run their cable and enter the buildings by the rear by air lines from the alley poles. But even they are met with suits for injunctions—which, if Judge Hagner's decision stands, must be granted. In their case the difficulty can be met for there will always be some one with public spirit enough, to permit the single pole required for his square to be put up on his own premises. But another question comes up. If the commissioners cannot grant authority to put up air lines where is their power to have the carriage-ways, side-walks, parking, etc., torn up to lay the necessary conduits? May not any citizen whose place is passed sue out an injunction?

The United States Electric Light Co. whose proposed expansion has hitherto been mentioned, had secured a site in Georgetown with extensive water-power; obtained permission to run their wires partly above and partly underground, arranged for the necessary funds by the issue of bonds and were all ready for a very material enlargement of their plant, when confronted with the action of the Court. As a consequence they are at a standstill. All negotiations have been stopped, and they will continue business at the old stand to the extent of their present capacity. Should the Court in general term sustain Judge Hagner, it makes all permits heretofore issued for poles void, and Congress will have to legislate upon the subject.

The daily press has had numerous notices of the Washington Monument being struck by lightning, until a portion of the capstone was split off, necessitating the restoration of the scaffolding to bolt on the fractured piece. While this was in progress, tests were made of the resistance of the conductor, and it was shown to be $2\frac{1}{10}$ ohms. The aluminum tip was found badly battered. This tip is connected by a copper rod through the cap-stone with the heavy wrought-iron work that supports the elevator, and the bottom of this iron work is supposed to be connected with a well below the concrete base of the shaft. Where this resistance comes in has not been explained. From the published daily reports it would appear that those in charge are seeking to increase the facilities for collecting electricity rather than providing better means for its discharge into the ground.

A short time since, by the light of the moon, the wires of the Southern Telegraph Co. which connected with the Bankers and Merchants' line, were cut and quietly connected with wires leading into the office of the Western Union company, and the Southern is made a part of the Mutual Union *alias* of the giant monopoly. Efforts had previously been made for a connection with the Baltimore and Ohio system, but the terms offered by the latter were not deemed sufficiently liberal to warrant the connection, and so the Southern goes the same way as hundreds of like local lines have gone before. The Bankers and Merchants' and the Postal bid fair to be no exceptions to the rule, and when they reach a certain stage may follow all their predecessors. Experience seems to have no effect in deterring people from embarking in small telegraph enterprises, and if these lines should be "gobbled" by the Western Union, new lines would probably be started over the same route on which the House, Bain, Independent, Insulated, Franklin, Bankers and Brokers', Commercial, and a half dozen others, perished.

Col. Wilson, the new commissioner of public buildings and grounds, is getting restless under the delay in removing the wires from the treasury building and executive mansion, and has notified the companies interested that if they are on the 1st proximo he will have them cut down. As there seems to be no authority anywhere to give permission to put up poles or to lay cables, the companies are in a quandary, and are waiting for "something to turn up."

A day or two since a police officer arrested four small boys for climbing telegraph poles in the street to get a sight of Buffalo Bill's Indians, who were giving their wild western exhibition in Athletic park. The lads were brought before the police judge, who decided there was neither trespass nor disorderly conduct on the part of the boys, and dismissed the case. The youngsters evidently read the papers, for they now climb the poles around the base ball grounds, and the police have to content themselves with driving the smaller ones away from the knot-holes in the high board fence, on the plea that they trespass upon the parking between the sidewalk and fence.

WASHINGTON, June 24, 1885.

WILLIAMSPORT, PENN.

The Edison Lighting System.—Abandonment of Meters.—Proposal for Street Lighting.—The Telephone Business.—Adoption of Hard-drawn Copper Wire.—Systematic Inspection of Lines and Equipments.

ALTHOUGH a city of but 25,000 inhabitants, Williamsport has shown great interest in electric matters. In order to establish an electric lighting system $100,000 was raised for the erection of an Edison central lighting station of the most approved and substantial form. It is a large brick building equipped with two 180 h. p. and one 140 h. p. Buckeye engines, and 4 large steel boilers equal to 500 h. p. The engines were set up with the greatest care running the dynamos direct, and it is spoken of as the model central station in this country. There are nearly 4,000 10-candle-power lamps which are furnished at about the same price as gas at $2,00 per 1,000 ft. The new station was started Oct. 1884, and has been increasing gradually ever since.

The meter system was abandoned, and special contracts made shortly after the station was started. The lines are all well and substantially built all overhead, or pole lines. The plant has a capacity of about 8,000 lamps which number no doubt will be subscribed for in due time. The company has made a proposition to the city council for the street illumination, which is to be awarded soon.

This is the headquarters of the Central Penn'a Telephone and Supply Co. Williamsport was among the first cities in the state to adopt the telephone, the exchange being open in April, 1879. Williamsport and Wilkesbarre, each with about the same number of subscribers (425), have been equipped with the multiple switch

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boards. Scranton, Pa., the largest exchange of the company, having about 550 subscribers, was furnished with the same switch board about a year ago. All the smaller exchanges have been equipped within the past two years with the most improved Western electric switches and the lines erected, especially the extra-territorial, are fully up to Western Union standard. For a number of the lines No. 12 hard-drawn copper wire has been used. The company will erect about 100 miles of this wire this season to replace some of the more busy iron lines, that better service may be given. The line connecting Wilkesbarre and Scranton exchanges (a No. 9 iron wire) has been duplicated by a No. 12 copper line on an independent set of poles and by a different route, to accommodate the increased business, between these points. By these lines no difficulty is experienced in talking 100 miles, the annunciator drops in switch boards, all being shunted. Great care is taken to provide the highest standard of service throughout the entire territory of this company, the most improved machinery, and close inspection of lines, instruments, etc., being required.

WILLIAMSPORT, Penn., June 25, 1885.

ELECTRICAL NEWS AND NOTES.

PRESENTATION OF THE HENRY MEMORIAL TABLET.

ADDRESS OF EDWARD N. DICKERSON, ESQ.

Alumni day at Princeton, June 16, was the date selected for the presentation to the college of the memorial tablet, the gift of several friends of the late Professor Joseph Henry. The tablet has been placed in Marquand chapel. It is of marble with a medallion bust of Professor Henry in the centre. Edward N. Dickerson, Esq., of this city was invited to deliver the presentation address, which was not only an eloquent tribute to the memory of the great scientist, but is of special interest as showing the importance of his discoveries in their relation to the telegraph system as it exists to-day. At the request of the college officers, the address is being published in pamphlet form, from the advance sheets of which we are enabled to present it in full.

Mr. President and Gentlemen, Trustees of the College of New Jersey:

The pleasing but sad duty has been assigned to me of presenting to you this memorial tablet of the beloved master, who once shed the lustre of his genius over this ancient seat of learning, and once attracted to its classic shades, allured by his great reputation, pilgrims from all lands, to drink from the living font of knowledge, ever replenished and refreshed by his ceaseless contributions.

I commit this monument to your tender care May it ever remain enshrined in this beautiful temple. May its presence encourage those, and the successors of those, to whom he delivered his torch of science, ablaze with a light which had penetrated to the farthest ends of the earth, to tend that sacred flame, so that when they shall transmit it to their successors, it shall still be borne high aloft in the upper atmosphere of pure truth, with still increasing lustre—a guiding beacon to the wayfarer, wandering and astray in the gloomy valleys of ignorance ; those deep defiles, where the shadows seem ever darkening by contrast with the brightening mountain tops illumined by the rising sun of knowledge.

May it inspire the ingenuous youth, who in the thronging years of the future shall gather about these altars, to search the character and achievements of the great master ; that they may be taught by him how to study ; how to think ; how to work ; how to live ; and how to die.

May it continue to remind those who annually are attracted here to witness the evidences of the growth of knowledge, as they are exhibited in the commencement seasons, that once this college was honored by the ministrations of Joseph Henry, an American, who, with means created almost wholly by himself, rivaled the achievements of the greatest scientists of the old world, working with the resources of nobly endowed institutions, and encouraged by the bounty of kings ; and for years was ever a leader in the vigorous attack upon the arcana of nature, made by the champions of science in the early years of this century.

For those of us who enjoyed the happiness of knowing him well, and loving him dearly, no sculptured marble is needed to stir our hearts, or to keep fresh in our memories that noble presence, which at once charmed and satisfied our senses. Nor, if the chisel of the artist were guided by the genius that once inspired Phidias, would it be capable of fixing upon dull, cold marble, more than one of the almost infinite variety of expressions revealing to the world without, the exalted being within.

But to those who have never seen him, or having seen him have never known him, and to those who shall come after us, it will be something to look upon this marble, and inspired by the thoughts he uttered, and the deeds he did, contemplate its calm expression, and imagine what must have been the living man.

In the year 1839, nearly half a century ago, brought here as a student, I first saw Professor Henry. I remember it well—the time, the place, and the surroundings. Boyish imagination had pictured the great discoverer as a venerable man, bowed down with the toil of years, bearing the furrows, with which overtasked nature revenges herself, traced upon his brow—such a person, perhaps, as the artist has presented to us in the familiar picture of Humboldt in his library.

How different the reality ! In the maturity of a perfect manhood he stood :

> " A combination, and a form indeed,
> Where every god did seem to set his seal,
> To give the world assurance of a man."

His clear and delicate complexion, flushed with perfect health, bloomed with hues that maidenhood might envy. Upon his splendid front, neither time nor corroding care, nor blear eyed envy, had written a wrinkle, or left a cloud ; it was fair and pure as monumental alabaster. His erect and noble form, firmly and gracefully poised, would have afforded to an artist an ideal model for an Apollo. The joy of conflict and of triumph beamed from his countenance—a conflict in which, for years, he had struggled with the phantoms that guard the hidden treasures of nature, and had ever been victorious. And above all, surmounting all, infinite charity and gentleness—like the charity and gentleness of a loving mother for her erring children.

To him the youthful student bowed down in profound admiration. To him, and to his memory, for nearly fifty years he has clung with ever-increasing love and affection. And now that seven years have passed away since death severed the bond, strengthened by a life-time of intimacy, he recurs with fondest memories to the many happy occasions when it was his good fortune to spend hours in sweet and instructive converse with this gifted mortal, to whom the whole book of nature was an open volume, out of which he ever read lessons of wisdom, and beauty, and truth.

As Professor Henry appeared in 1839, so he continued till 1847, with but little change in the physical man—only that change, which, like the changes in the early autumn, lightly touched with tints of exquisite beauty the mature growth of springtime and summer ; and then, with extreme reluctance, he departed from Princeton, called by his country to lay down the arms with which, as a soldier in the ranks, he had been waging his warfare against ignorance, and to take command of the intellectual forces to be summoned and organized by him in the same glorious cause.

Born in the dying moments of the eighteenth century, his age was marked by the numbers denoting the years of the nineteenth. But, like the century, with whose growth his growth kept pace, he had developed with almost unexampled rapidity ; and at the age of thirty-two, wheh he took his chair here, although " he was but a youth, and ruddy, and of a fair countenance," and was armed only with a simple sling of his own construction, and pebbles from the brook of nature, he was equal to the trained warriors of maturer growth and superior armor, waging battle against the Goliah that guarded the unexplored regions of nature's secrets ; and like the great king of Israel, after the brunt of the battle was over, he came to be a leader of the hosts, who once had been tending only a " few sheep in the wilderness."

Let us contemplate for a moment the intellectual stature of our departed teacher, considered merely as an investigator of natural laws, and measured by the standard established by the intellectual world

It is in the order of nature that the intermittent progress of humanity is made under the guidance of gifted men, appearing from time to time, who push forward the outposts of truth, whether in morals or physics, calling upon their fellow men to hasten and occupy the newly-conquered fields. The names of such men are few, and are written upon the rolls of fame. Their glory belongs to no nation, but to all mankind. Sometimes simultaneously and in different parts of the world two such appear, who seem to have been cast in similar moulds, lest perchance one might die or fail, and progress stand still. Such men were Henry and Faraday, whose intellects were molded with the same capacities, and who worked out their tasks in the same spirit. If either one had died before his work was done, the other was capable of doing it : and, in fact, both in many cases struck out the truth, each unconscious that the twin thought had been born in the brain of the other.

To those devoted friends and admirers of Faraday, who delight in singing his well-earned praises, and who best comprehend his achievements, it seems that his discovery that electricity might be produced from magnetism, was his grandest result. Upon it depends many of the most important applications of electricity to the uses of man ; and in the near future many more are coming. Tyndall, the successor of Faraday, does not restrain his enthusiasm when he contemplates this achievement. " I cannot help thinking," says he, " while I dwell upon them, that this discovery of magneto-electricity is the greatest experimental result ever obtained by an investigator. It is the Mont Blanc of Faraday's own achievements. He always worked at great elevations, but higher than this he never subsequently attained."

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Let us accept the standard, and apply it to Henry; let the achievement measure the power of the man.

In November, 1831, Faraday read before the Royal Society his memorable paper "On the Evolution of Electricity from Magnetism," illustrated by drawings of the apparatus, in which figure 1 is the *compound* "spool," discovered by Henry in 1828, and which Faraday used in making his discovery. No publication referring to this paper had reached this country till April, 1832, when a vague reference, made to it in the *Annals of Philosophy*, was seen by Henry, which led to his publication of July, in *Silliman's Journal*, where he gave a full account of this great discovery, made by himself before he heard of Faraday's work, which, when compared with Faraday's paper of November, exhibits Faraday's experiment for solving the problem. When he wrote his paper, Henry, misled by the imperfect statement in the *Annals of Philosophy*, supposed that his experiment had differed from Faraday's, but was undeceived when the full publication reached him. In 1831, a teacher in the Albany academy was very remote from London and the Royal Society.

In that same year, and in the same few weeks, Faraday first, and Henry after him, independently made the discovery of magneto-electricity; "the greatest experimental result ever obtained by an investigator," in the opinion of Tyndall.

In the same field, and during the same years, were the other great scientists of the world studying the same subject: Ampère, Arago, Oersted, Davy and a host of others; but these two did it, and not the others; and Henry did it by devices of his own invention, unaided by anything which Faraday had discovered or produced, while Faraday used Henry's electro-magnet in performing his most important experiment.

The towering heights which were scaled by the daring spirit of Faraday from the east were at the same time surmounted from the west by our own countryman. Both were climbing from opposite sides at the same time, and neither was conscious of the other's efforts till both stood, face to face, upon the summit. Had Henry been furnished with the corps of trained mountain guides and Alpine stocks, such as attended Faraday in his ascent, perhaps *his* foot would have first trodden the peak, and Prof. Tyndall's song of triumph have been addressed to him.

But when we compare Henry with Faraday, who is the acknowledged unit of comparison, the accidental conditions under which both existed and worked must be known, or justice cannot be done. Electrical science was the field to which both spontaneously directed their studies. Its mysteries at once excited curiosity and baffled research. Its most obvious phenomena had only for a short time been recognized, and everything was to be learned. What they did in that science not only constitutes the greater part of their claims to reputation as investigators, but is almost the whole of our present knowledge of magneto-electricity.

But how superior in every respect, except in God-given intellect, was the equipment of Faraday! He was eight years older than his rival. In the year 1813 he was appointed assistant in the laboratory of the Royal Institute, under Sir Humphrey Davy, then one of the foremost scientists of the world, who, attracted by Faraday's genius, was directing his studies and forming his mind. At that time Henry was but 13 years old.

In the next 12 years Faraday was at work, with all the resources of the Royal Institute, under the instruction of the great Davy, in acquiring the knowledge with which he was armed when he began his original investigations; while Henry, during that same period, was struggling unaided for such education as might be obtained from the scanty resources of a country town; and with that proud independence, ever so marked a feature of his character, was supporting himself by teaching to others a part of that which he was learning himself.

In 1825, Faraday had so improved his great opportunities, that at the age of 34 he was appointed "director of the laboratory" of the Royal Institute, where everything that science could suggest and money procure was at his command in aid of research. Henry was then a private tutor in a distinguished family at Albany, studying mathematics in hours when his duties to his pupils had ceased, and when other young men might have thought they had earned the right to relaxation and enjoyment.

In 1824, before Henry ever had in his hands any instruments for research in electricity, Faraday, thus trained and equipped, began his attack upon the problem of magneto-electricity and failed; and in 1830 it was not yet solved.

The discoveries of deductive science need no apparatus. They are made and matured in the brain; and to record them is the only physical incident to their existence or development. Plato would have looked with disgust and contempt upon a laboratory, and would have scorned the suggestion that time, or place, or physical surroundings, could affect the workings of his mind, or influence his deductions. But the new philosophy, which has changed the face of the world, is of no such ethereal nature. It is born in observation of physical things; it is nurtured upon experiments that cost money, and time, and labor; its maturity is in perfected arts and in things to be seen, and handled, and enjoyed by the senses; its end is to subordinate the blind forces of nature to the uses of man—to mitigate the ills and multiply the joys of life. Those who are the servants of this philosophy must be provided with materials with which to reproduce, in miniature, the conditions that exist in nature in grander proportions, or they cannot ask the questions whose answers they are seeking; and, other things being equal, he, who is well provided with all these needful things has an immense advantage over another who lacks them.

For 13 years Faraday had been pursuing his investigations amply supplied, and was in the full career of successful experiment, when, in 1826, his great rival first looked upon the course over which he was to run, and even then Henry had to depend upon the meagre facilities of the Albany academy, and the voluntary assistance of an appreciative physician, Dr. Philip Ten Eyck, of Albany—a name to be held in grateful remembrance by all who feel a pride in the achievements of the great scientist, whose early efforts were assisted, and whose hopes encouraged, by this enlightened friend.

With such a beginning as this, who could expect that the young aspirant for fame should ever overtake his great leader in the friendly contest? And when he did overtake him, and in some important investigations surpass him, who shall deny that Henry, as a physical investigator, was the equal of him above whom it is conceded no other man has risen in this century?

In still further pursuing his researches into the subtle phenomena of electricity, Henry made, here in Princeton, another capital discovery, this time in advance of Faraday, which forms an important element in the science of electricity. It is to be found detailed in any school-book, under the name of "Henry's coils." His wonderfully elaborate investigations will be remembered by the students of that day, as they were conducted in part in the open air. Wires stretched across the campus, in front and in rear of Nassau Hall, were the means by which the questioner was cross-examining nature, and wresting from her reluctant grasp her hidden secrets. At that time telegraph wires did not exist, and those fine lines traced across the sky excited the liveliest interest in the students, whose fantastic guesses as to their significance were the cause of much pleasantry in the idle hours.

In the course of these investigations it was also the good fortune of our scientist to first discover the very curious phenomenon of "self induction," as it is now called, which plays so important a part in the creation and use of electric currents on wires, sometimes injuriously and sometimes beneficially. Without the knowledge of its laws no duplex or quadruplex telegraph could be practically operated; with that knowledge it can be neutralized when it is injurious, and made available when useful. The brilliant spark which follows the pulling of the pendant, attached to an electric lighter for inflaming a gas jet, now in common use, is one of the valuable practical applications of this principle so discovered.

In contemplating the discoveries of the scientist, there are two aspects in which they present themselves. In one view we consider merely the difficulty of the achievement; in the other, the value of the result to mankind. The first view is obvious when the thing is done; the other is to be reserved for a future day, when all the consequences have followed the original cause. The first view is that which measures the power of the man, just as the lifting of a huge weight by some Hercules exhibits his strength, even though the thing done may be, or may seem to be, useless. The capital discoveries I have named, made by Henry and Faraday, exhibited the giant's strength when they were made, and measured the men who made them. They were found at great depths below the surface, where mental vision can only penetrate by the aid of lenses constructed *in advance, in accordance with the very laws for whose discovery they are needed*—creations of the scientific imagination, and called scientific hypotheses. In such creations Professor Henry was excelled by no man.

Time will not permit even a hasty review of all the scientific labor done by Professor Henry at Princeton, during those years when his chief duties were instruction, and when he had only a portion of his time in which to work for mankind and for reputation; and I must be content with a passing glance at a part of it.

Among those wires which were strung across the campus in 1835 was one used for a magnetic telegraph between the professor's home and his laboratory in the Philosophic hall; and that telegraph line was the first in the world in which the galvanic circuit was completed through the earth—one end of the single wire-circuit terminating in the well at the house, and the other in the earth at the hall. Steinheil, in Munich, in 1837, worked his electric telegraph in the same way by a single line wire, using the earth as part of the circuit, over much longer distances; but it was first done in this campus.

Nearly a century earlier our great countryman, Franklin, had drawn from a surcharged thunder-cloud, upon the string of a kite, in a pouring shower of rain, the lightning of heaven, and had demonstrated its identity with the puny spark of an electrical machine; and with that capital experiment his fame is more closely associated than with any other of the great truths he discovered. In these grounds that experiment was amplified, and still further results obtained, by the man for whom the mantle of Franklin had been waiting all those years, and who was the only

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American whose stature would not have been dwarfed by assuming it.

From the clear, blue sky, with two kites, one above and assisting the other, held by a delicate wire wound on an insulated reel, Professor Henry drew down streams of brilliant sparks, intensified by the self induction of the wire itself ; thus proving the electrical relations of the earth and its envelope. So, a child's plaything in the hands of a master, reveals the hidden mysteries of the universe.

Away beyond the distant horizon we see at times a quivering illumination of the sky, but hear no thunder. How shall that phenomenon be questioned? Fifty years ago, Henry converted the metallic roof of his house into a great inductive plate, by soldering to it a copper wire, and leading that through an electro-magnetic coil to the ground ; and with that he held converse with the distant lightning, so far away that its voice could not be heard. If the gods of mythology, who hurl their thunderbolts, have a system in their signals, this apparatus would enable us to read their thoughts. Within a few months, a device has been put into operation by which telegraphic communication is kept up between the running cars on railroads and the stations, so that the positions of all the trains may at any time be known, and protection against collisions assured. To do this the metallic roof of the car is used as an inductive plate, just as was the house roof 50 years ago ; and a wire passes from it through a signaling coil to the ground by way of the metal wheels and track. Near the roof, outside, an electric wire is stretched on poles, through which electric flashes, like lightning, are sent, and they set up by induction in the roof electric currents similar to those passing over the wire, which are read as signals by the observer ; and, conversely, signals are sent from the roof to the wire by induction coils in the car. The experimental demonstration in Princeton has not been lost, though buried so long, and to day it throws another safeguard around our lives.

The first electro-magnetic engine for generating power was made by Henry, at Albany, in 1831. His clear mind was not deluded into the belief that such an apparatus could supersede the steam engine as an economical motor, and he warned the world against that delusion. Zinc, as fuel in a battery, is more costly than coal in a furnace. Still, he saw and said that in exceptional cases it might be useful ; a result now coming to pass, dependent, however, upon the discovery of magneto-electricity by which galvanic batteries are dispensed with, and electricity, made in quantities from some great and economical source of power, is distributed to Henry's machines wherever they may be.

In many volumes, some of which have perished by fire, and some remain, were laid out lines and plans of investigation by Professor Henry, needing only leisure and means for their development, covering fields where other investigators have since reaped rich harvests of fame, but from which he was debarred by the pressure of his other occupations here. In those records are contained the evidence that the great intellect, which did so much with so little, was capable of grasping the whole circle of physical science, and of enriching and adorning any department of it to which his efforts might be directed.

But he was destined for another career. A benevolent Englishman, inspired by the noble ambition to aid in elevating mankind, had bequeathed to the United States a great sum of money to be used for "the increase and diffusion of knowledge among men." It was a splendid gift, and a sacred trust. Who was to be found equal to the task of effecting this grand purpose? The civilized world was interested in that question. Mankind was the beneficiary of the trust; and all men were entitled to be considered in its administration. By the common consent of the wisest and best of Europe and America, Professor Henry of Princeton college was selected, and solicited to assume that onerous duty. What tribute was that to the achievements, the attainments, and the character of the man? He must be famous, that his selection might at once command the assent of the world; he must be learned, that he might be able to carry out the purposes of the donor; and he must be virtuous, that he should not degrade the high office to any base or selfish uses. And thus he was called.

When brought to the parting of the roads, choice was extremely difficult. On the one hand, a life devoted to the most delightful of all pursuits—the searching out of the laws of nature, which are the thoughts of God ; a reputation already great and daily growing ; and a happy home, surrounded by congenial and loving friends, and undisturbed by cares for the present or the future. On the other hand, an abandonment of the field of scientific research, where the harvest was abundant, and the laborers few; and a surrender to others of the prizes which he saw glittering before him in the race he was running; and furthermore a grapple with the problems of organization and finance, and with the discordant elements which the scheme of the Smithsonian institution would necessarily evoke. He foresaw that he *might* find himself, after some years had passed, like a giant shorn of his strength ; on the one side outrun in the race where he had ever been in the lead ; and on the other so hampered and crippled as to be unable to accomplish the great objects for which alone he was about to abandon his first love. That high sense of duty which governed him in every act of his life decided the question, notwithstanding his firm conviction that in accepting the trust he left the happiest days of his life in the past.

Perhaps he might have decided otherwise if Princeton college had been then as it is now. Perhaps he then might have felt, that with such ample resources at his command as are now to be found here, his services to humanity might be greater as a soldier in the ranks than as a commander in the field. But at that time no one had arisen among the friends of this institution who, like the Medici of the fifteenth century, was able at the same time to gather the wealth of the world by the arts of honorable commerce, and to appreciate that the gathered wealth of the world owes its existence and preservation to science, to art, and to literature ; and that, therefore, it is due to education that it should be encouraged by noble gifts, such as have enlarged the capacity of the college of New Jersey, and reflected honor upon the names of those whose generous hearts, guided by wisdom, have lead them to broaden these ancient foundations, and to arm with improved facilities the workers who are here devoting their lives to the advancement of knowledge. All honor to such men. Had such assistance come earlier, the career of the great scientist might have been different; but it was not to be, and thenceforth another life opened before him, and another man was unfolded to the world.

Perhaps the highest praise that can be bestowed upon any man, is to say of him that he is just equal to all the duties ever imposed upon him, and never above them; that his reserves are not called into action until the emergency requires them. Such men are the great benefactors of mankind. Such a man was the secretary of the Smithsonian Institution. The principles he laid down for the administration of the noble gift of Smithson required time for their development, and promised no present brilliant results. The foundations were to be laid deep in the earth, where the laborer and his work were scarcely to be seen by the passer-by. No popular applause would greet the achievement for years to come, while popular clamor was ever ready to cry out against the waste of time and money that produced no instant fruits. The man of clear purpose and resolute will, stood guard over the work ; and with just force enough, and no more, drove off the assailants till the foundations were all secure, the superstructure begun, and it was strong enough to stand alone.

With the skill that would have adorned a professional diplomatist, he temporized and compromised, when he could no longer contend with success ; with the dash that would have illustrated a general, he attacked when the moment was propitious, and the adversary off his guard. With the earnestness of sincere conviction, and with the directness of demonstration with which his scientific training had armed him, he convinced, one by one those who opposed his views, until at last the regents of the institution, and Congress, surrendered their judgments to his, and the field was won.

A great library was the dream of Mr. Choate, the most scholarly and persuasive of advocates ; and as a regent, he possessed and wielded a formidable power. It was hard to persuade him that a library does not "*increase* knowledge among men," and that it was very likely to "*diffuse*" ignorance. To discover and accumulate new truths, and to diffuse them over the whole earth, was the secretary's conception of the donor's intention ; to pile up in Washington a miscellaneous collection in print of *old* truths and *old* errors, was the idea of the scholars; and they were so strong that a temporary compromise was necessary. The vigorous growth of the true conception at last overshadowed the false one, and the library no longer saps the life of the institution. Professor Henry always thought that over every library portal should be written some such warning as "*cave canem*"—beware of the lies.

It was not till 1852 that the serious attacks upon the Smithsonian came to an end. On the 24th of June, of that year, a United States agricultural convention, met in the theatre of the Smithsonian building. The plan to plunder the institution seems to have been carefully considered and matured; and the officers of the Smithsonian were elected members of the convention. Stephen A. Douglas was at that time at the height of his power. He had risen from the ranks by the arts of the politician, and was the most influential man in the Democratic party of that day. Although not yet forty years old, he had just succeeded in defeating General Cass in a contest for the presidential nomination at Baltimore ; and although he failed by a few votes to secure it, he had thrown it to Franklin Pierce of New Hampshire, and thus kept it open for himself in 1856, as the western candidate of the party.

He was styled the "little giant"—not in derision, but in admiration, as expressing the combination of a small stature and great intellect. Representing in the convention what was then an almost entirely agricultural constituency, he thought that votes were to be got, and his influence strengthened, if he could bring home to them the spoils of the Smithsonian ; and accordingly a resolution was introduced petitioning Congress to appropriate a portion of the Smithsonian money for an agricultural bureau ; and Judge Douglas undertook the congenial task of accomplishing the raid. The recollections of that battle are

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among the valued treasures of memory, associated in my mind with Joseph Henry. In such an assemblage, and with such a cause, Douglas was an adversary to be feared by any man. That he was an accomplished politician was proved by his great success; and he was there to fix another step in the ladder by which he had climbed so high. His speech was adroit, as only he could make it. Its argument was founded upon the proposition that civilized man depends upon agriculture, without which barbarism would sweep over the land; and his conclusion was that the farmer was entitled to whatever assistance could be got out of the money of Smithson, whose benevolence could best be applied in encouraging those who were at the very foundations of civilization. It would be great injustice to Judge Douglas to assume that he supposed the diffusion of papers of turnip seed among farmers was that sort of "increase and diffusion of knowledge among men" designed by Mr. Smithson; but no doubt it would be an increase and diffusion of the knowledge that he was the friend of the farmer, and that was of more importance to him. The secretary, surrounded by a few earnest friends, and prepared for the assault, sat in the back seat of the theatre quite unnoticed, kindling with righteous indignation at this nefarious plot to confiscate the funds of which he was the chosen guardian, and to destroy the institution devised by his intellect, reared by his unceasing efforts, and guarded so far by his sleepless vigilance.

When the popular applause following the "little giant's" popular speech had subsided, the secretary arose. In measured and dignified words he presented himself as the guardian of that fund, bound so far as in him lay, to defend it from spoliation. He first developed the moral aspects of the question, and appealed, over the head of the advocate, to the honesty of the constituents he represented; expressing the most generous confidence that the farmers of this country would never consciously be parties in an attempt to seize that which belonged to mankind in general, or seek by a forcible partition to destroy the unity and efficiency of the fund.

The legal aspect of the question he next discussed like an equity lawyer, and denounced in scornful sentences that attempted breach of trust which was implied in the resolution.

And then, out of the fullness of his knowledge, with abundance of illustration and example, he demonstrated that the discovery of new truths, and their application to the arts, had elevated the farmers from the mere drudges they were in the seventeenth century to their present high state of intelligence and comfort.

The effect was overwhelming; and the "little giant" must have felt that there was another giant there to whose title no diminutive prefix could be properly applied.

The meeting adjourned till the next day, and these significant words were written in the secretary's diary, under date of June 25: "Judge Douglas, toward the close, made an apology for the warmth of his expressions. I did the same. Judge Rusk followed—so the whole was amicably settled."

Since that day no further assaults have been made on the Smithsonian Institution; and it stands a proud monument to the genius, the learning, the labor, and the character of the great secretary; who was content to sink his personality in the impersonal institution—to be overshadowed by the creature of his own creation, in order that true knowledge might the better be increased and diffused among men.

The conscientious obligation he felt pressing upon him to lose no opportunity for diffusing knowledge and correcting error, imposed a vast amount of unrecognized and unrequited labor. The intellectually halt, and lame, and blind, continually resorted to him for help, either in person or by letter; and they never were sent away empty. Like the home of the lovely country parson in the Deserted Village:

> "His house was known to all the vagrant train;
> He chid their wanderings, but relieved their pain."

They who have witnessed some of those deeds of charity, will never forget the gentle patience with which he listened to the beggars for knowledge, and the simple way in which he conveyed to their imperfect intelligences the truths they were seeking. Their self conceit was often offensive; but he knew it was the product of ignorance, and his effort was to cure the disorder. He was no more repelled by the disagreeable symptoms, than the physician is who must treat a loathsome disease. On one occasion, in my presence, one of these cripples refused to accept the instructions of the great physicist on a very simple question of dynamics, applicable to a project he had in hand; but instead of dismissing him, the master quietly took down "Hutton" from the bookcase, and patiently read that author's confirmation of the law he had been teaching. What an exhibition of true humility! Perhaps, thought he, "I can give a new direction to this man's mind, who may yet do something useful; and what matters it that he scorns me."

No one can form a just estimate of the vastness of his mind, of the extent and accuracy of his learning, and of his power to discern the correlations of knowledge, who has not carefully read the instructions mapped out by him for the guidance of investigators working under the auspices of the Smithsonian Institution. They constitute a set of charts, which, for years to come, will guide the explorer safely and surely in future voyages for the discovery of new truths; and are a monument attesting the fidelity with which the great trust was executed, and vindicating the sagacity of those eminent men, who, in 1846, saw, what his innate modesty forbade him to see, that Joseph Henry was, of all living men, the most fit to administer a fund whose object was "the increase and diffusion of knowledge among men."

Passing by thus hastily the great achievements illustrating the long and happy life of Henry, let us examine with more particularity his connection with the electro-magnetic telegraph; whose creation has so largely modified the course of modern civilization, and endowed the dull earth with nerves, like those of the living frame, whereby the whole body of mankind instantly feels the joys or sorrows of any of its members.

How to communicate intelligence instantly, over distances so great that the voice cannot be heard, had been well known to organized societies from remote antiquity. Visible signals, made by moving vanes by day, and lighted torches by night, were known to Greeks and Romans alike; and more recently the alphabet was associated with these movements, so that alphabetical messages were freely communicated.

Even barbarous nations and tribes possessed this art in a high degree of perfection; and the arrival and progress of Cortes in Mexico were communicated by telegraphic signals, corresponding with the sign language of the Aztecs, to the capital of the doomed Montezuma.

When atmospheric electricity came to be artificially generated, it occurred at once to ingenious men that it might be used for telegraphy; and, in 1774, the first electric telegraph ever constructed was established at Geneva by Lesage. He used 24 wires, each connected with an electroscope, whose function it is to move when the wire is charged with electricity, and by means of which any of the letters of the alphabet could be transmitted, by simply discharging a prime conductor of an electrical machine into the wire corresponding to that letter. This complicated apparatus was subsequently improved by using only one wire, and causing lettered wheels to revolve synchronously at the two stations, so that the same letter would appear at the same time to both operators. By this apparatus, whose principle of synchronous revolution is the same as that now used in the printing telegraph, the sender would simply close the circuit on his electrical machine when his revolving wheel presented the desired letter, and the pith-ball electroscope, moving at the receiving end at the same instant, would indicate to the receiver that the letter then presenting itself to him on his wheel was the one intended.

A number of other inventors used static electricity for the same purpose during the latter years of the last century, and the earlier ones of this. In England, Ronalds had a line of eight miles, on which the wire was suspended from poles, and insulated by silken strings; and in 1796, Salva, in Spain, worked a line by static electricity 26 miles long.

In the year 1800 Volta produced the voltaic pile, and gave to the world that new manifestation of electricity called "galvanism." In that form this subtle agent is far more manageable than in the form of static electricity; and by the use of galvanic batteries a current of low tension but of enormously greater power can be maintained with little difficulty; whereas static electricity is like lightning, and readily leaps and escapes from the surfaces on which it is confined. The galvanic current also readily decomposes acidulated water and many other substances, and this capacity was soon applied to the purposes of telegraphy. Sœmering, in 1807, invented a telegraph on this plan, and continued it for several years in Munich, publishing accounts of it in scientific journals, and exhibiting it to learned societies. Others followed in his lead, until finally it came into commercial use in England in 1846, as a rival to the electro-magnetic telegraph of later invention, but requiring its aid, as an alarm.

In 1820, Oersted discovered the capital fact that a galvanic current, passing through a wire placed horizontally above, and parallel to, an ordinary compass needle, will cause that needle to sway on its axis to the east or west, according to the direction of the current through the wire. At once Ampère suggested the application of the new discovery to the old telegraph, whereby galvanism might be substituted for static electricity, and the deflection of a magnetic needle for the divergence of the pith-ball of the electroscope. Baron Schilling, a Russian nobleman, inspired by the love of science, accordingly took up this suggestion and constructed a galvanometer or needle telegraph, which, in a practical and operative form, was exhibited to the Emperor Alexander in 1824, and came to be well known to scientific persons at that time.

In 1833, Gauss and Weber set up a *single circuit* galvanometer telegraph on this plan at Gottengen, leading the wire over the house-tops, on insulators, as we do now; and by the deflections of the needle to the right and left made up the alphabet, as it had been done before when using other means for moving the vanes.

Their apparatus, however, is perfectly silent. The needle is suspended by a thread when the noiseless current sways it to and fro with but feeble force; and it is incapable of calling the attention of the operator to receive its message. These were serious

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difficulties, to be overcome by other principles and other inventions, which would supersede this one.

Following Oersted, Arago, in France, in 1820, made the next capital discovery. It was but a little thing he saw—simply that a sewing needle, surrounded by a coil of wire, through which a voltaic current passed, had become magnetic; but that little thing has grown to be mighty. This observation was the complete discovery of electro-magnetism, which had been dimly seen in Oersted's galvanometer, and was the germ of the electro-magnet. For *four years* this beautiful discovery was experimented with by all the scientists in Europe before another step was taken; and then William Sturgeon, of England, produced the electro-magnet. It consisted of a large soft iron wire, bent into a horse-shoe form, coated with varnish, and wrapped with a spiral coil of naked copper wire from end to end, through which the voltaic current might be passed. This bent wire became a magnet while the current flowed, but lost its magnetism when the current ceased.

Here, then, was born into the world an apparatus capable of exerting a strong power at the will of the operator, by merely opening and closing the voltaic circuit; and it was then thought that the difficulties in the way of the telegraph were conquered. The experiment was soon tried with Sturgeon's magnet by Barlow, an eminent scientist; and in January, 1825, he published his results in the *Edinburgh Philosophical Journal*, in these words:—

"The *details* of this contrivance "(a telegraph)" are *so obvious*, and the *principle on which it is founded so well understood*, that there was only one question which could render the result doubtful; and this was, is there any *diminution of effect by lengthening* the conducting wire?" If not, he proceeds to say: "Then no question could be entertained of the practicability and utility of the suggestion above adverted to. I was, therefore, induced to make the trial; but I found such a sensible *diminution with only two hundred feet of wire*, as at once to convince me of the *impracticability of the scheme*."

Barlow's experiment was repeated by other scientists in that and following years with a like result; until it came to be accepted in the scientific world that the telegraph could not be worked with the newly-discovered electro-magnetism. So strongly was this fixed in the opinion of the day, that as late as 1837—*thirteen years after the invention of the electro-magnet by Sturgeon*—so eminent a scientist and discoverer as Wheatstone pronounced the electro-magnetic telegraph impossible, on an occasion when the very question was submitted to him for decision by Cooke, at the suggestion of Faraday himself. This fact is so important, and so conclusive on the question now under examination, that I read Wheatstone's own account of it, submitted by himself to arbitrators who were to decide a controversy between himself and Cooke as to their respective merits as inventors of one form of the electro-magnetic telegraph. He says:

"I believe, but am not quite sure, that it was on the first of March, 1837, that Mr. Cooke introduced himself to me. He told me he had applied to Dr. Faraday, and Dr. Roget, for some information relative to a subject on which he was engaged, and they had referred him to me as having the means of answering his inquiries. * * Relying upon my former experience, I at once told Mr. Cooke that *it would not, and could not, act as a telegraph, because sufficient attractive power could not be imparted to an electro-magnet interposed in a long circuit;* and to convince him of the truth of this assertion I invited him to King's college to see the repetition of the experiments on which my conclusion was founded. He came, and after *seeing a variety of voltaic magnets which, even with powerful batteries, exhibited but slight adhesive attraction, he expressed his disappointment.*"

Cooke confirms this statement by saying: "It was my inability *to make the electro-magnet act at long distances* which first led me to Mr. Wheatstone."

Let the difficulty of making the discovery which overcame this impossibility be judged by the fact, that for so many years, such men as these were unable to do it when it was needed; and let that fact answer the envious suggestion that Henry's achievement involved no great amount of analytic and inventive power.

When Barlow's demonstration was published in 1824, Henry had never seen an electro-magnet, nor tried an experiment in electricity. When, however, two years later he took up the subject, and began the first set of regular scientific investigations ever attempted in the United States, he deduced from Ampère's law the principle that the voltaic currents, carried on wires around the iron core of the electro-magnet, should move in planes at right angles to the axis of that core—which they could not do even approximately if the core itself were insulated, as in Sturgeon's small magnet, having only one coil of naked wire wound spirally around it, necessarily leaving open spaces between the successive spirals, and so leading the current like a corkscrew around the core. He also reasoned that, as the current *must* be led through a spiral circuit, which theoretically should be circular, the departure from its true course might be counteracted by winding the wire on a second spiral outside of the first, but with its spiral angle opposed, so that the resultant of the current from the two spirals would be the same as if it revolved in planes at right angles to the axis of the core.

He brought his reasoning to the test of experiment. Instead of insulating the core, he wrapped a fine copper wire with silk, and wound it on the core; each spiral closely packed against its fellows, so as to correct the spiral error as much as possible in each layer; and then he wound the wire in a second spiral over the first, but with the pitch of the screw, so to speak, in the opposite direction. And carrying out the principle, he multiplied the coils to an enormous extent in the same way. The result justified and established his theory; and his magnets at once showed a capacity hundreds of times greater than any then known to science.

But this was not all. Another step had to be taken before Barlow's demonstration could be overthrown, and the telegraph made possible. And this he took by discovering and establishing the fact, that a magnet with a long fine wire coil must be worked by a battery of "intensity," composed of a large number of cells in series, when a *distant* effect was required; and that the greatest dynamic effect, close at hand, is produced by a battery of a very few cells of large surface, combined with a coil or coils of short coarse wire around the magnet.

These discoveries and inventions solved the problem which had seemed to European scientists insoluble; and in one account of them which was published in *Silliman's Journal* for January, 1831, he says: "The fact that the magnetic action of a current from a trough is at least not sensibly diminished by passing through a long wire, *is directly applicable to Mr. Barlow's project of forming an electro-magnetic telegraph.*" This reference was to Barlow's paper of 1824, in which he had demonstrated the impracticability of the telegraph.

Had these things been done in the Royal Institute, and read before the Royal Society, Wheatstone would not have been found, in 1837, denying the possibility of an electro-magnetic telegraph; and Faraday would have been able to answer Cooke's question, without sending him to Wheatstone for the information. In those days, however, the United States were held in no higher estimation in Europe than Nazareth was in former days in Jerusalem; and no one in England read an American book.

But not content with having reasoned out, and demonstrated, that *distance* was no longer the sole impediment in the way of the magnetic telegraph, Henry, in 1831, established the first electro-magnetic telegraph that ever existed. In the Albany academy he strung a mile of line wire, and with an "intensity battery" at one end, and his spool of long fine wire at the other, he operated the armature of the first *sounding* telegraph of any kind. When the armature was attracted by the magnet, it struck a small bell or sounder, which spoke its signals; and that apparatus there was maintained to illustrate the telegraph to the students.

When applied to practical use, some code of signals must be arranged for translating the successive taps of the armature; but that was well known in the telegraphic art for ages, needing only good judgment in arranging it, so that the letters which occur most frequently shall be represented by the smallest number of motions; just as Gauss and Weber arranged their needle telegraph code in 1833, when the movements of their needle to and fro, in a number of simple combinations, indicated the alphabet.

These "spools" of Henry have been the means by which most of the great discoveries in electro-magnetism have since been made. Faraday and Henry used them in their famous researches already referred to, in which they discovered magneto-electricity. Sturgeon, in writing of them, says: "Professor Henry has been enabled to produce a magnetic force which totally eclipses every other in the whole annals of magnetism; and no parallel is to be found since the miraculous suspension of the celebrated oriental impostor in his iron coffin." Without them we could not have the telegraph, or the still more marvelous telephone. They are to-day essentials of modern living, and are as familiar to us as spools of cotton. Judging by their results, they constitute the most important discovery which has ever been made in electricity since Volta created the battery.

Henry also put in operation at Princeton, in 1835, the very simple and obvious plan of using the "intensity spool and battery," working through long distances, to open and close the circuit of a "quantity spool and battery," stationed where the work was to be done; thus making the powerful magnet, at short range, the servant of the weak one at long range. In this state he left the problem entirely solved, to those who could procure the money to practically apply his discoveries to the commercial uses of man.

That task was no easy one. In 1831 there were no railroads and no steamships. Over rough country roads the mails were carried in wagons or coaches, and the postage on a single letter was a shilling for short distances, and twice as much for longer. But little capital had accumulated in this country; and corporations, those powerful instruments for uniting the slender means of the many into a compact force for the development of great industrial enterprises, were hardly known. If the most perfect telegraph apparatus of to-day had been then presented to the public, no company could have been formed to exploit it. The time had not yet come; nor could it come until railroads were built, and the exchange of material things had been rendered easy.

In Europe, where money and railroads were more abundant,

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the telegraph was first put into practical use. Wheatstone and Cooke, in England in 1838—having first, however, seen and talked with Henry on the subject in 1837, *after* they had first decided the thing to be impossible—established a practical commercial telegraph line between Paddington and West Dayton, a distance of 13 miles; and a shorter line was in Munich. In this country private capital could not be raised for the purpose at all; not because there was any doubt that the thing could work, but because no one supposed it would repay the investment; as it certainly would not have done in those early days. At last Congress was induced to do what private enterprise refused, and in 1844, six years after the English lines had been in practical operation, and seven years after the Bavarian money was appropriated for the line between Baltimore and Washington. This was accomplished, after great exertions, by persons hoping for the reward which a patent for some of the contrivances connected with that particular plan promised.

Neither in England, where Wheatstone had a patent founded on Henry's inventions, nor here, where Morse had a similar one, could the telegraph have been introduced for years after it really was, but for the beneficent operation of the patent laws. But few men are to be found who will incur the risks, and expend the money, incident to the introduction of a new and untried industry, without the hope of that pecuniary return which, in such cases, can only be secured by the exclusive use for a limited time of the new thing, during which it is hoped that the original losses may be repaid, and a profit earned.

Let us now consider what would have been the position of Henry in the world, if at any time before his inventions had been put so long into practical public use that he had lost the rights to do so, he had taken a patent for—

First, His magnetic spools, pure and simple.

Secondly, The combination of a magnetic spool of long fine wire, with an "intensity battery," for the purpose of producing a practical magnetic effect at great distances.

Thirdly, The combination with such an apparatus of a quantity battery, operating upon a spool magnet of coarse and short wire, at a distance from the intensity battery; whereby the great lifting power of the quantity magnet might be controlled by the intensity combination.

And finally, The combination of the intensity battery and spool, with a vibrating armature, so arranged as to strike a sounder when the circuit is closed or opened at the sending end, for the purpose of transmitting intelligible messages telegraphically.

All these he might have patented in the United States at any time during several years after his discoveries and inventions were made; and he could have held them against the world. That he was the first man to do all these things is not in doubt anywhere. If he had taken such a patent, even as late as 1837, he would have controlled the telegraph in this country, certainly until 1851; and unless he had then been adequately rewarded for his great inventions, his term would have been extended till 1858. Imagine the good he would have done to science had the wealth which this would have produced been poured into his purse!

But listen to his noble words: "At the time of making my original experiments in electro-magnetism in Albany, I was urged by a friend to take out a patent, both for its application to machinery, and to the telegraph; but this I declined, on the ground that I did not then consider it compatible with the dignity of science to confine the benefits which might be derived from it to the exclusive use of any individual."

Pure science was his beloved, and he could not make merchandise of *her*.

When that sentence was written, other eminent scientists had thought differently of this question, and had patented their discoveries; and lest he might seem to cast a reproach upon them, and to say, "I am holier than thou," his humble spirit added these words: "In this, *perhaps*, I was too fastidious."

It must have occurred to him at times, when he needed money for his experiments, and when he saw the fruits of his labor enriching the world, that he *might* have taken some share of the wealth; but he would not taint with selfishness his generous gift. How valuable in money it was he knew full well. Even for that fragment of it, then for six years by him given to the public, which was carried to Morse in 1837 to enable him to construct his special plan of a recording telegraph in that year, now practically obsolete. Dr. Gale, who carried it, received a share in the patent which was founded upon it, and without which it could not have existed. For that share $15,000 in cash were subsequently paid to him. And its use for the telegraph was but a small part of its infinite variety of applications to the arts, and the purposes of man.

Come with me now into a telegraph office, and let us see what we find there. If the line be a short one, say 30 or 40 miles, you will see but one of Henry's spools, fixed to a table, having a piece of iron called an "armature," capable of vibrating in front of its poles, and so arranged that when the "spool magnet" attracts it, it will vibrate and strike a sounding-bar of sonorous metal, which gives out distinctly the sound of the tap. The "spool" is wound spirally in layers with several hundred feet of fine copper wire, covered with silk, in the manner specified by Henry in *Silliman's Journal*. At the other end of the line is a battery, composed of a number of cells in series, called by Henry for distinction an "intensity battery"; and the wire circuit is supplied with a simple device, so that it may be opened or closed by the operator's finger. When he closes it, a current of electricity flows from the "intensity battery" along the wire, and around the coil of the "intensity magnet," and the armature strikes the sounder and gives the signal. The listener hears it; and as the order of the taps progresses in accordance with a pre-arranged artificial code, to express the letters of the alphabet by combinations of successive taps—just as the old visible signals were arranged by combinations of the successive movements of the vanes, or afterwards of the needle of the Gauss and Weber telegraph—he hears letter after letter tapped out, and the message is understood.

Now, that apparatus has nothing about it more than was in Henry's Albany telegraph of 1831; nor could it operate if it omitted any one of the inventions, either singly or together, which were then for the first time combined. It depends entirely upon the discoveries made by Henry before 1831; and it could not have existed in the world earlier than those discoveries, by the use of any means then known to man; nor since by any other means than those discovered by Henry.

Henry used a bell as a sounder; they now use a metal bar and a sounding box. Henry reversed the battery current, whereby no spring is needed to withdraw the armature for the purpose of vibrating it; and that is the common practice in English and German telegraphs. Here they generally merely interrupt the circuit, and the armature is withdrawn from the magnet by a spring; although Henry's device is also used here largely, and is essential to the quadruplex instruments.

If, however, the telegraph line is a long one—it may be a thousand miles or more—then you will see two sets of Henry's spools, and two batteries. One is the "intensity battery and spool" first described; and the coil of fine wire may be, and often is, several thousand feet long—while the battery is composed of more than a hundred cells. The distance being so great, they do not attempt to send force enough through the intensity circuit to operate a sounder, but only to open and close the local circuit of Henry's quantity battery and spool. That circuit consists of a battery of but one or two cells of large surface, and a spool with about a hundred feet of coarse wire wound around its core. The intensity combination opens and closes this quantity circuit, whose armature strikes the sounder, just as the intensity armature itself does on shorter lines. This obvious plan Henry described and exhibited in Princeton to his classes, long before any magnetic telegraph was ever commercially constructed, or the convenience of such an arrangement had resulted from the great length to which the lines are stretched.

Upon that apparatus there are but four names to be written —Oersted, who discovered the effect of the voltaic current upon the magnetic needle; Arago, who discovered that the voltaic current could generate magnetism; Sturgeon, who produced the first electro-magnet; and Henry, who discovered the conditions under which an electro-magnet might be operated at a distance—who invented the devices by which it could so operate—and who applied those devices to an operative telegraph, of the same form and substance as that now in use all over the world. Beyond their discoveries and inventions nothing is essential to the present telegraph, except that which was of common knowledge when those discoveries were completed, and that ordinary mechanical skill which is far below the level either of discovery or invention.

This is the record, and so it will stand forever.

"The moving finger writes; and having writ,
Moves on: nor all your piety nor wit
Shall lure it back to cancel half a line,
Nor all your tears wash out one word of it."

Forty years had fled away since as teacher and pupil we first met, and they seemed like a dream that is past, when again we met to part forever in this world. In the chamber where the angel of death hovered over him, just ready to call him away, he talked thankfully of the past, and hopefully of that eternity on whose verge he stood. The vigor of youth and of manhood had been all spent in the service of humanity, and his strength was gone. The pallor of disease had dispelled the delicate hues of health, and time had traced its furrows on his brow. But the unclouded intellect still held its sway, enthroned in that magnificent head on which the snows of many winters had drifted; and the gentle loving spirit still, as of old, illumined his beautiful face, but with a clearer, warmer light, reflecting the heaven upon which he gazed. For himself he had but one regret—that he had not been spared to complete his last great labor, by which he hoped to confer still one more benefit upon humanity, by discovering some means affording greater security for mariners on the treacherous coast, when fogs shut down their impenetrable veils over the lights, and the syren's voice fails to pierce the fickle air.

The faithful servant—faithful unto death—only mourned that he could not have done more. With the humble spirit of the true Christian, after having, in the estimation of his fellow-men,

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done so much, he, knowing better than others how much was yet to be done, exclaimed: "I am an unprofitable servant."

Such a life and such a death exalt and glorify humanity; illustrating and indelibly impressing upon our hearts the great truth, that man is made in the image of God.

"Along the smooth and slender wires, the sleepless heralds run,
Fast as the clear and living rays go streaming from the sun;
No peals or flashes, heard or seen, their wondrous flight betray,
And yet their words are quickly felt, in cities far away.

Nor summer's heat, nor winter's cold, can check their rapid course;
Unmoved they meet the fierce wind's blast, the rough wave's sweeping force.
In the long night of rain and wrath, as in the blaze of day,
They rush with news of weal or woe to thousands far away.

But faster still than tidings borne on that electric cord,
Rise the pure thoughts of him who loves the Christian's life and Lord;
Of him who taught, in smiles and tears, with fervent lips to pray,
Maintains high converse, here on earth, with bright worlds far away.

Aye, though no outward wish is breathed, nor outward answer given,
The sighing of that humble heart is known and felt in heaven.
Those long frail wires may bend or break, those viewless heralds stay;
But faith's last word shall reach the throne of God, though far away."

THE INSULATED OFFICE-WIRE CASE.

THE WESTERN ELECTRIC MANUFACTURING COMPANY *v.* THE ANSONIA BRASS AND COPPER COMPANY.

Supreme Court of the United States.

APPEAL from the Circuit Court of the United States for the District of Connecticut.

Decided April 20, 1885.

Complainant's reissued patent for an improvement in insulating telegraph wires, which covers a product, falls with his original patent, which covered a process, for the following reasons:

1. The process consists in compressing the wax or other suitable material into the pores of the fibrous covering of the wire without scraping off any part of it. This process was anticipated by letters patent to Dundonald and to Baudouin in Great Britain, which describe the compressing of the wax, &c., to attain the same result, namely—the insulation of the wire. The patent is therefore invalid.
2. The difference between the complainant's and the Baudouin process consists merely in the use of a greater quantity of wax. This may be an improvement on the latter process, but it does not involve invention.
3. The allegation of complainant's that one of the features of its process is allowing the wax to cool before compressing it is not sustained by any mention of this feature in either the specification or claim of its patent. As the claim fails to describe this feature, it cannot be held to be covered by the patent.

STATEMENT.

The case was a suit in equity brought by the appellant, the Western Electric Manufacturing Co., against the Ansonia Brass and Copper Co. to restrain the infringement of two reissued Letters Patent, numbered 6,954 and 6,955, respectively, granted to the appellant as the assignee of Joseph Olmsted, both dated February 29, 1876, for improvements in insulating telegraph wires. The reissues are divisions of original Letters Patent No. 129,858, dated July 23, 1872. The descriptive specifications of the two patents were identical. They differed only in the claims, the first being for a process and the second for the product of the process. The specification of both patents, after stating that Olmsted had invented a new and useful improvement in insulating telegraph wires proceeded as follows:

The method of insulating now in use consists in braiding over the wire a fibrous covering, after which it is dipped in wax for the purpose of filling and closing its pores, and, after a subsequent scraping to remove the surplus wax, it is ready for use. This method is, however, objectionable, inasmuch as it leaves the covering in a very rough and soft condition, and fails to secure perfect insulation.

In my improved method, after the wire has received its coating I dip it in paraffine or wax, after which, instead of scraping off the surplus coating, I pass the whole through a suitable machine, which compresses the covering, and forces the paraffine or wax into the pores, and secures perfect insulation. By so compressing the covering the paraffine or wax is forced into the pores, and the surface becomes and appears polished.

Wire insulated in this manner is entirely impervious to the atmosphere, of greater durability, and less cumbersome than any heretofore made

The claim of the process patent (No. 6,954) was as follows:

The method of insulating telegraph wires, by first filling the pores of the covering, and subsequently compressing this covering, and thereby polishing its surface, substantially as described.

The claim of the product patent (No. 6,955) was—

An insulated telegraph wire the covering of which has its pores filled and its surface polished, substantially as described.

The defendant denied in its answer that Olmsted was the first and original inventor of the improvement described in the patents, or of any substantial or material part thereof, or that the same was patentable or the subject-matter of invention, and that the alleged invention had been previously patented by Letters Patent of Great Britain, granted to Thomas, Earl of Dundonald, dated July 22, 1851, and by Letters Patent of Great Britain granted to Felix M. Baudouin, dated April 3, 1857. The defendant also denied infringement. The Circuit Court, on final hearing, dismissed the bill, and the plaintiff appealed.

Mr. George P. Barton for the appellant.

Mr. William B. Wooster for the appellee.

Mr. Justice Woods delivered the opinion of the Court.

It is clear that the two patents must stand or fall together. If the patent for the process is invalid, so must be the patent for the product. What we have to say will refer to the process patent. The alleged invention described in the patent is not for insulating telegraph wires, for that art long antedated the original patent. The specification disclaims as a part of the invention the braiding of a fibrous covering over the wire and then dipping it in wax for the purpose of filling and closing the pores, and the subsequent scraping of the surplus wax from the wire The patent does not cover the material in which the wire, after it has received its fibrous coating, is dipped, which may be either paraffine, wax, or bitumen, or any other suitable material. The three substances mentioned had long been used for that purpose. Nor does the patent specify or cover any device by which the process is to be carried on. Any suitable machine may be used. The process described by the patent consists, therefore, simply in this: After the wire has received its fibrous coating and been dipped in paraffine, wax, or other suitable substance, the compressing and forcing of the paraffine, wax, or other substance without scraping off any part of it, into the pores of the fibrous material by some suitable means. We think this process was not new. It was substantially anticipated both by the process described in the patent of Dundonald and in that of Baudouin, the first dated January 22, 1852, and the other April 3, 1857. Dundonald describes his process thus:

I also employ a bituminous material to cover, and thus insulate, the conducting-wires of electric telegraphs which are intended to be placed underground. For this purpose I employ the said bitumen, either simple or compounded, of a flexible description, and pass the wire through it when it is in a melted state, then causing the wire to pass through some die or orifice which will deprive it of all the superfluous bitumen. * * The incasement of this wire with bitumen may also be effected by covering it with a filamentous material which has been previously saturated with melted bitumen, and then passing the wire so covered through a heated die or orifice, so as to melt or soften the bitumen upon the filamentous material, and press the whole of the coating against the wire in such a way as to cause it to form one compact continuous covering of the wire, and thus insure its insulation.

The patent of Baudouin describes his process as follows:

My invention relates to the preparation of conductors of electricity for electric telegraphs, being wires insulated to prevent the loss or deterioration of the electric currents used for that purpose, and also in the machinery for the preparation or manufacture of such conductors. I coat the wires with bituminous or such like fatty matters that are not liable to become hard or cracked, but, on the contrary, are constantly acted on by the temperature of the atmosphere. Coatings of this material in themselves are insufficient to maintain the proper protection and insulation for telegraph conductors, but when combined with other materials—such as paper, woven fabrics of cotton, silk, wool, or hemp, in a particular manner—are well adapted for the purpose.

I prefer to use three ribbons and bobbins for this purpose, the first covering of the wire being enveloped by the second in such manner that the helical junction of the first ribbon is covered by the second, and the second by the third. The wire is passed through a bath of hot bitumen, and has the superfluous matter removed by passing through suitable dies or parts to scrape and smooth its surface and render it of uniform thickness. The first and second ribbons are also passed through bituminous or other suitable matter to render them more impervious to electricity. The coated and lapped wire is passed through suitable dies to remove superfluous matter, to smooth down the lapping of the ribbons, and to compress and cause their proper adhesion. The coated and lapped wire passes through dies or smoothing-holes both in entering and leaving the rotating frame. These dies or smoothers have a rotary motion, the better to enable them to wipe and smooth the coated wire.

It is plain that these patents anticipate the process set out in the specification of the Olmsted process patent. They all three describe the compressing of the wax, paraffine, or bitumen coating of a wire covered with the fibrous material, so as to attain the same result—namely, the insulation of the wire. The Olmsted patent, therefore, covers an old process applied to the same subject with no change in the manner of applying it, and with no result substantially distinct in its nature. It cannot therefore be a valid patent. *Penn. Railroad* v. *Locomotive Truck Co.* U. S., 490; *Vinton* v. *Hamilton*, 104 U. S., 485.

The fact that in the process described in the Olmsted patent the surplus wax or paraffine is not scraped off, but all that adheres to the wire is compressed against it and forms part of the covering, is relied on to distinguish that process from those of Dundonald and Baudouin; but the Dundonald process does not differ in this respect from that of Olmsted, for in the Dundonald process the whole of the coating is pressed against the wire and is left to form the covering; and as to the Baudouin process, the difference consists merely in the use of a greater quantity of wax or paraffine to form the coating. This may be an improvement upon the Baudouin process, but it does not involve invention.

So far as the present case is concerned, another answer to this contention of the appellant is that in this respect the defendant follows the Baudouin, and not the Olmsted process, by scraping off the superfluous coating material.

It was insisted in argument by appellant's counsel that one of the features of the process described in the Olmsted patent was the allowing of the wax or paraffine covering to cool before compressing it upon the wire, and as this was not done in the Dundonald or Baudouin process they did not anticipate the Olmsted process. But neither the specification nor claim of the Olmsted patent mentions as a part of the process the cooling of the wax or paraffine coating before compressing it upon the wire. The appellant's counsel, however, contends that it must be considered a part of the process, because the polished appearance of the surface of the covering described in the specification is the result of allowing the paraffine or wax to cool before compressing it upon the wire. But, clearly, a patentee cannot claim the benefit of an element of his invention thus vaguely and indefinitely hinted at. The law in force when the patent of Olm-

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sted was issued (Act of July 8, 1870, section 4888, Revised Statutes) requires that—

Before any inventor shall receive a patent for his invention or discovery he shall file in the Patent Office a written description of the same and of the manner and process of making, constructing, compounding, and using it in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains or with which it is most nearly connected to make, construct, compound, or use the same, and he shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery.

It is clear that if the patentee intended to include the cooling of the wax or paraffine before compressing it upon the wire he has failed to describe in his specification that element of his invention, as required by the statute. Instead of describing the process he mentions a quality of the product and asks the Court to infer the process from that quality. Such a vague and inverted method of description is not a compliance with the statute. That part of the alleged invention is not even referred to in the most distant manner in the claim. It has been held by this Court that—

The scope of letters patent should be limited to the invention covered by the claim; and though the claim may be illustrated it cannot be enlarged by the language in other parts of the specification. (*Railroad Co.* v. *Mellen*, 104 U. S., 112.)

The element of the process under consideration cannot, therefore, be held to be covered by the patent. The contention that the patentee intended to include it in his process is evidently an afterthought.

The result of the views expressed is that both the patents sued on are void.

Decree affirmed.

THE BRUSH-SWAN ELECTRIC LIGHT CO.

The offices of this company have been removed to numbers 204–210 Elizabeth street, New York city. There will be on exhibition at these rooms, all of the varieties of electric lighting apparatus manufactured under the Brush-Swan patents.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

President J. F. Morrison, announces that all electric light companies, manufacturers of electric light apparatus, machinery and supplies, who desire to become members of the National Electric Light Association, must make application on or before August 1st, 1885. All communications addressed to him at Baltimore, Md., will receive prompt attention. The next meeting of the association will be held at the Union Square Hotel in this city on August 18th.

THE NATIONAL TELEGRAM COMPANY.

Although the general news of the day is collected, and distributed by different press associations, they do not cover the entire field for the reason that many newspapers require a special service embracing various matters, in which their readers are particularly interested. It is for the purpose of performing such supplementary service that the National Telegram Co. has been organized by C. H. Bogle and W. C. Pearse, both of which gentlemen have been for many years identified with the press and telegraphic service. Base-ball and other sporting intelligence will be judiciously served out, and the sermons of popular divines transmitted to such journals as desire them Special sales of goods will also be carefully reported. The company will patronize all the different telegraph lines.

THE ELECTRICAL EXHIBITION TESTS.

Although the actual tests at Philadelphia have been substantially completed, the task of calculating and classifying the results from the great mass of recorded data will require some weeks of hard labor, which the continuance of the present insufferable hot spell may serve to prolong. The announcement of certain results alleged to have been obtained, which has been made in several of the daily newspapers, and which has called forth some adverse criticism, is entirely premature.

THE TRAIN-DESPATCHERS' CONVENTION.

The American Train Despatchers' Convention, held recently at Denver, adopted a uniform system of rules and train orders. They favor the use of double orders when practicable; recommend that conductors be only required to sign train orders; favor trains losing their rights after becoming 12 hours late; recommend the use of time orders; favor in cases of emergency the running of trains against "hold orders" signed by the agent or operator; recommend that all conductors be required to pass an examination on time card and rules regarding running of trains, and recommend the use, both day and night, of stationary train-order signals, red and white—the normal position to be white, and moved to red when it is desired to hold trains.

SUIT BROUGHT ON THE SAWYER-MAN PATENTS.

On June 22d the Consolidated Electric Light Co. filed an application in the United States Circuit Court against Thomas A. Edison and the Edison Electric Light Co. for an injunction restraining the defendant from making, using, or selling the conductors for incandescent lights made of carbonized, fibrous, or textile material.

The injunction asked for is the result of a long period of fighting between Mr. Edison and William E. Sawyer as to the priority of discovery of carbon conductors of fibrous material. In January, 1880, the war began in the Patent Office as to whom the patent for such fibrous carbons was due. Commissioner Marble decided that Sawyer was entitled to the patent. Then came a time of appeals and applications for rehearings on Mr. Edison's part, but on May 12th last the patent was granted to Mr. Sawyer, or rather to the Consolidated Electric Light Co., which profited by his discoveries, as Sawyer died during the proceedings. H. R. Garden, who is one of the counsel for the Consolidated Electric Light Co, says that it will not be the company's policy to fight consumers in the suit against the Edison company. It simply does not wish the Edison people to go on manufacturing the carbon filaments without recompensing the company owning the patent. The motion for a preliminary injunction will be argued before Judge Wallace in the United States Circuit Court in a few days.

WESTERN UNION QUARTERLY STATEMENT.

The directors of the Western Union Telegraph Co. have declared a dividend of 1¼ per cent. for the quarter ending June 30. The statement on which the dividend was declared assumes that "the net revenues of the quarter ending June 30, inst., based upon nearly completed returns for April, partial returns for May, and estimating the business for June, will be about $1,400,000." If the company should really earn the amount estimated there would be a balance of $56,391 on the operations of the quarter. This would swell the "surplus" of the company to $4,303,334. Compared with the quarter ended June 30, 1884, the items stand:—

Net revenue (estimated)	$1,400,000	Dec	$350,000
Interest and sinking fund	143,768	Dec	232
Balance	$1,256,232	Dec	$349,768
Dividend 1¼ per cent	1,199,841	Dec	199,959
Balance	$56.391	Dec	$149,809
Surplus April 1	$4,246,943	Inc	197,126
Total surplus July 1	$4,303,334	Inc	$47,817

The dividend of one year ago was 1¾ per cent.

ELECTRIC LIGHT AND POWER.

The Salem (Mass.) Electric Light Co. has declared a semi-annual dividend of 3 per cent.

The Middlesex Electric Light Co. of Lowell, Mass., has re-elected its directors. The annual report shows: Gross receipts for the year $43,407.66; expenditures, $43,241.08; balance May 31, 1885, $166.58. The receipts from lights were $38,406.94; lighting expenses, $22,239; construction expenses, $9,340.93; lights in use, 235. The net earnings for the year were $11,497.90, or 8.7 per cent. on the 13,106 issued shares. The net receipts were applied to improvements, interest, etc., so that no dividend was declared. The balance sheet shows temporary loans of $20,000.

There are now 278 public and private arc lamps used in Hartford, Conn., and 16 more have been ordered which is beyond the supply of the present plant. A 75 h. p. engine and two 45-light dynamos are to be added.

The Cleveland Electric Light Co. has put in two additional dynamos and a third Westinghouse Automatic Engine.

The Lewiston (Maine) Electric Light Co., now uses saw-dust for fuel, costing only 75 cents per cord delivered. It finds this fuel more economical than screenings for making steam. Its boilers are set with the Jarvis patent setting, and use Sheffield grate bars. It uses the Armington & Sims engines belted direct to the dynamos.

A 200-light Weston incandescent plant has been installed in the College of Ottawa, Ottawa, Ont., by Ahearn and Soper of that city, representing the U. S. Electric Lighting Co.

The Jamestown (N. Y.) Gas Co., is preparing to introduce incandescent lighting into the business portion of the city. The system to be adopted is now under advisement.

The city of San Diego in southern California will soon be lighted by electricity. An effort is being made to organize a similar movement in Santa Barbara.

The Woolley Electric Light Co. is fitting up an entire train on the C. I., St. L. & C., to light it by electricity, the same engine that runs the machinery for the locomotive's electric headlight to furnish the power which lights the train.

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The Badger Illuminating Co. has been incorporated in Illinois to furnish electric lights and manufacture electric apparatus; capital stock, $64,000; incorporators, Leonard M. Hodges, Henry P. Robbins, Alpheus C. Badger.

The Newark, N. J. city council has accepted the proposition of the United States Electric Lighting Co. to light the city. The same company expects to soon erect a tower light in Orange, N. J.

On May 26th the new station of the Municipal Electric Light Co. of Brooklyn, E. D., was opened. It is a new and substantial brick building 60x100 feet. The present plant consists of five Buckeye engines with a total of 390 h. p. driving 10 dynamos. The lighting capacity is about 400 arc lamps. There is sufficient space to permit the increase of machinery to double the present amount.

The New London Electric Light Co. is putting in a 60 h. p. Westinghouse engine.

The Superior and Duluth Electric Light Co. has filed articles of association with the Secretary of State in Illinois, its object being to furnish electric light and power in the county of Douglas, Wisconsin, and the county of St. Louis, Minnesota. The capital stock is $100,000, divided into 1,000 shares, and the incorporators are J. H. Hammond, C. H. Catlin and W. V. Noad.

An effort is being made to establish an electric light plant at Greenfield, Mass., and a committee has been appointed to make arrangements to see where the most central point will be for its location. Quite a number of the citizens have expressed a willingness to light their places of business by it.

MANUFACTURING AND TRADE NOTES.

The carbons made by the Forest City Carbon M'f'g Co., Cleveland, Ohio, for whom Messrs. Holmes, Booth & Haydens are sole agents, are giving excellent satisfaction, and although they have been on the market but a very short time, their sales are increasing so rapidly that they are now building a factory 50x200 feet in which they will put the best machinery, and will soon be able to turn out about 600,000 carbons per month.

SUBTERRANEAN LINES.

Mayor Low of Brooklyn, has appointed G. W. Plympton, Rossiter W. Raymond and John Reynolds, as Commissioners to enforce the law for placing the wires underground.

SUBMARINE CABLES.

A despatch from Buenos Ayres says that Minister Osborn, acting in accordance with instructions received from the State Department, Washington, has concluded a contract securing to the Central and South American Telegraph Co. a concession to establish cables between Buenos Ayres and Rio Janeiro and land lines between Buenos Ayres and the Pacific side, thus securing to an American company continuous and independent telegraphic communication between the United States and Brazil. The necessary decree has been signed by the President of the Argentine Republic.

THE TELEGRAPH.

At Chicago on June 6, Judge Blodgett granted the Postal Telegraph Co. an injunction restraining E. A. Howell, of Pennsylvania, from obtaining execution of a judgment of $61,266, the company representing that to sell any portion of its lines would seriously damage its entire property.

The Bankers and Merchants' company has announced the following rates at Boston. 10 cents to New York, Providence, Hartford, Fall River and Newport; 20 cents to Philadelphia, Baltimore and Washington; 25 cents to Chicago, Cleveland, Buffalo, Rochester and Pittsburg.

The Baltimore and Ohio Telegraph Co. is preparing to mount its long-distance messengers on bicycles at Saratoga, Long Branch and Niagara Falls. If the pace is too slow the machines will fall over, and it is believed that little difficulty will be experienced in recruiting the force.

At the annual meeting of the Association of Railroad Telegraph Superintendents, held at Cleveland June 17, the following officers were elected: C. W. Harmon, St. Louis, president; George L. Lang, Boston, vice-president; P. W. Drew, Chicago, secretary and treasurer. Explanations were given of two systems designed to utilize inductive effects of currents of electricity, whereby messages can be sent to and received from moving trains. The association will next meet in St. Paul, June 18, 1886.

THE TELEPHONE.

The total number of telephone exchanges in existence in this country Jan. 1st, 1885, was 772. Miles of wire in use, 101,734. Employés, 5,168. Subscribers 134,847. The increase in the number of subscribers during the year 1884 was 11,222.

An answer to the patent infringement suit of the Bell Telephone Co. against the Western Pennsylvania Telephone Co. was filed in the United States Circuit Court at Pittsburg, Pa., June 23. The defendants deny the validity of the Bell patent on the ground that the invention was known 15 years before Bell or Edison took out patents by which control of the system is now claimed.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From May 12th, to June 9th, 1885 (inclusive).

Alarms and Signals:—*Bells*, C. Henzel, 318,472, May 26; A. H. Palmer, 318,647, 318,674; E. F. Recordon, 319,318, June 2. *Burglar Alarm*, J. Barkheimer, 319,058. *Automatic Responding Instrument*, A. G. Holcombe, 319,-718, June 9. *Programme Signal*, R. B. Carr, 319,782.

Clocks:—*Alarm Clock*, Victor Gallet, 318,612, May 26. *Secondary*, C. A. Hussey, 319,259, June 2. *Circuit closer for Clock*, W. F. Weisberger, 319,534, June 9. *Watchman's Clock*, R. B. Carr, 319,783. *Watchman's Time Recorder*, A. Howard, 319,818.

Commutators:—*Connecting Device for Switch-boards*, E. W. Smith, 318,929, May 26. *Switch*, A. J. Holt, 318,987, June 2. *Automatic Cut-off for Batteries*, L. Soulliere, 319,635, June 9.

Conductors, Insulators, Supports and Systems:—*System of Electric Light Distribution*, J. C. Allen and S. A. W. Gould, 317.960, May 19; W. S. Andrews and T. Spencer, 318,157; W. M. Thomas, 319,347, June 2. *Manufacture of Insulating Material*, J. L. Clark, 318,233, May 19. *Electric Way*, W. E. Banta, 318,411. *Joint for Pipes*, Wm. Hassall, 318.616, May 26. *Composition for Preserving Insulating Tubing*, J. W. Ellis, 319.079. June 2. *Preparation of Insulating Material*, J. A. Fleming, 319,084. *Underground Conductor*, B. L. Nevius, 319,112. *Machine for Making Insulator Clips*, E. Dodge, 319,206. *Conductor*, W. H. Sawyer, 319.326, June 2. *Conduit for Conductors*, W. Cohlman, 319,197; B. L. Nevius, 319,420. *Supporting Bracket for Conduits*, G. B. Bryant, 318,951. *Insulator*, G. L. Broomhall, 319,447, June 9. *Method of Making Conductors*, J. J. Williamson, 319,536.

Dynamo Machines and Motors:—*Dynamos*, J. S. Dubois, 318,091, May 19; A. G. Waterhouse, 318,671, May 26; L. G. Woolley, 319,540, June 9; G. A. Hamilton, 319,578. *Armature for*, D. A. Schuyler, 318,664, May 26. *Motor*, L. G. Woolley, 318,589. *Engine*, W. A. J. Kohrn, 319,912, June 9.

Galvanic Battery:—*Carbon Battery Electrode*, H. F. B. Schaefer, 318,300, May 19. *Battery*, M. J. Myers, 319,923, June 9.

Ignition:—*Primer*, S. Russell, 319,627, June 9. *Cartridge*, 319,628, 319,629. *Fire-arm*, J. W. Frost, 319,898, June 9.

Lamps and Appurtenances:—*Arc*, W. F. Buckley, 318,350, May 19; L. G. Woolley, 319,539, June 9; H. Pieper, 319.745; A. Bossard, 319,781. *Combined Gas and Electric Lamp Fixture*, C. Deavs, 318,547, May 26. *Incandescent Lamps*, E. L. Roussy, 319,129, June 2; L. Heinze, 319,580, June 9. *Holder for*, A. Bernstein, 319,177, June 2. *Lighting Apparatus*, E. Arnould, 319,-380; H. B. Gale, 319,573, June 9. *Process of Carbonizing Paper*, S. E. Trott, 319,353, June 2.

Measurement:—*Meter*, J. Cauderay, 318,166, May 19.

Metallurgy:—*Process of Electro Depositing Copper*, Moses G. Farmer, 319,-687, June 9. *Process of Smelting Ores*, E. H. and A. H. Cowles, 319,795. *Smelting Furnace*, same, 319,945.

Miscellaneous:—*Apparatus for Registering the Flow of Fluid and Detecting Waste*, J. C. Ayer, 318,227, May 19. *Marine Governor*, B. J. Carroll, 318,417. *Automatic Instructor*, W. L. Gates, 319,224, June 2. *Governor for Steam and Fluid Engines*, A. L. Ide, 319.260. *Torpedo Boat*, W. S. Sims, 319,633, June 9. *Combined Electric and Water Ram*, F. E. Fisher, 319,805.

Protectors:—*Protection of Men from High Tension Currents*, P. B. Delany, 318,172, May 19. *Combined Lightning Arrester and Test Connection*, H. B. Lytle and J. A. McCoy, 318,571, May 26. *Lightning Arrester for Wire Fences*, 319,300, June 2. *Safety Catch Plug*, S. Bergmann, 319,384.

Railways and Appliances:—*Signaling Apparatus*, W. Hadden, 317,994, May 19. *Train Signaling*, E. T. Gilliland, 318,102. *Railway*, B. Bidwell, 318,594, May 26. *Method of Operating Electric Railway Trains*, F. J. Sprague, 318,668. *Railway Signal*, O. S. Hertzog, 318,186, May 19; S. C. Pullman, 319,023, June 2. *Rail for Electric Railways*, S. F. Van Choate, 319,041.

Storage Batteries:—J. W. Swan, 318,828, May 26.

Telegraphs:—B. K. Boyle, 318,315, May 19. *Key and Sounder*, P. P. Belt, 318,854, May 26. *Sounder*, J. W. Delmege, 319,201, June 2. *Quadruplex*, G. Smith, 319,428. *Printing Telegraph*, G. B. Scott, 319,885, June 9. *Paper-Guard for*, C. Winkel, 319,770. *Unison Device for*, L. A. McCarthy, 319,001, June 2.

Telephones and Apparatus:—*Mechanical Telephone*, J. C. Rounds, 318,397, May 19. *Telephone Attachment*, G. R. Tyler, 318,057. *Transmitter*, E. H. Johnson, 319,415, June 2; J. P. Freeman, 318,423, 318,424, May 19; A. Berthon, 319,548, June 9; S. P. Nutt, 319,927. *Exchange*, J. A. Seely, 318,514, May 26; F. Shaw and W. A. Childs, 319,856, June 9. *Telephone Apparatus*, H. E. Waite, 319,043, June 2. *Telephone*, J. D. Husbands, 318,907, May 26; H. E. Waite, 319,042, June 2; C. E. Allen, 319,048. *Switch*, H. W. Comstock, 319,-789, June 9.

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THE ELECTRICIAN AND ELECTRICAL ENGINEER.

Conducted by F. L. POPE. R. W. POPE, Associate Editor.

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NEW YORK, AUGUST, 1885.

THE NATION MOURNS.

UPON Mount McGregor's summit, repose the mortal remains of America's greatest general, Ulysses S. Grant. Through his many months of patient suffering, the whole civilized world has watched the gradual encroachment of the final conqueror, to whom all must eventually surrender.

With the flitting of his last breath on the morning of July 23d, the telegraph, which in the past had been a most efficient aid in his achievement of victory, distributed the sad tidings of his death to the uttermost parts of the earth. Enshrined in the heart of the humblest citizen, whatever may be his nationality; loved and respected alike by democracy and royalty in every land, his fame will endure throughout all future ages.

Reflecting upon the grave circumstances through which he was enabled to attain distinction, let us hope that the humanizing influence of closer intercourse between nations, through the medium of electric communication over land and under sea, may eventually substitute the more enlightened measures of diplomacy for the barbarous acts of war.

SOWING THE WIND.

THE final disposition of the effects of impecunious and insolvent telegraph companies has usually heretofore been a very peaceful operation and one quietly acquiesced in by all interested parties, who recognized the hopelessness of a never-ending struggle against adversity. That the growth of competitive telegraph systems has for the most part gone on in the face of a series of hardships, arising from lack of capital, and in many cases of good management, to say nothing of the machinations of a wily opponent, all will admit who have ever participated in their exploitation, even in the most humble capacity. To the responsible managers of such concerns, consolidation is not infrequently welcome as a relief from the importunities of creditors and the supplications of unpaid employés. The recent seizure by the Western Union Telegraph Co. of the greater portion of the wires composing the system of the Bankers and Merchants' Telegraph Co., which was executed simultaneously and synchronously in various parts of the country, was perhaps the most sensational development in the way of telegraphic litigation that has yet been witnessed. The interests of the various bondholders, lessees, receivers, creditors and agents formed an almost unprecedented legal complication, which afforded an opportunity for the Western Union management, under color of lawful authority, to cut down and take possession of its competitor's working telegraph wires, without the slightest pretense of giving the formal notice required by common law, to say nothing of common decency. Except that human life may not have been endangered, this was an operation comparable to the sudden removal of a railway drawbridge over which trains were continually passing. We like to call ourselves a law-abiding people, and we sometimes are inclined to boast, especially in times of riot and excitement, that under a republican form of government almost every citizen can be depended upon to submit to the edicts of the civil authorities. But there are certain corporations which, under the protection of our national, state and municipal governments, have been permitted to clothe their executive officers with almost dictatorial power. Armies of employés are compelled to execute the decrees of these officials, or suffer the penalty. The consequence of refusal is not merely immediate loss of employment, for instances are not wanting where such corporations have even pursued the victim beyond their own jurisdiction, seeking to prevent him from honestly earning his bread under other masters. We refer to these facts as an example of the pressure of discipline under which honest-minded men may be forced to perpetrate acts they well know to be illegal, trusting to the implied protection of their wealthy and powerful employers for immunity from punishment. Having been granted a giant's power, these corporations elect to use it like a giant. It is very certain, however, that the people are becoming jealous of the creature of their own devising. Corporate strength has hitherto been respected because it has seemingly entrenched itself behind the law, unjust though it may appear to be. Now, however, under the feeble subterfuge of a "receiver's agency," the employés of the Western Union Telegraph Co. enter upon the premises of a neighbor and seize such property as they choose, regardless of the fact that this company has no jurisdiction over the whole, even if it has over a part, while the parties wronged are coolly informed that they may resort to the courts. So, too, may the man who is knocked down and robbed in the highway, but it can scarcely be pretended that the act of violence is thereby rendered legal. As a matter of policy, nothing can possibly be more injudicious than for a corporation like the Western Union, whose unguarded property is scattered over half a continent, to establish the hazardous precedent

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of using force and violence to accomplish its ends. The private citizen, or a mob of private citizens, may at some future time take the law into their own hands, rather than await the results of the slow operation of legal machinery. The people have submitted quietly to the gradual encroachment of these mighty engines of capital, but the keen-eyed observer sees many indications that a storm is brewing. That calm reliance upon the majesty of the law, and the physical support of the armed police and militia, will not always continue. How or when the storm will break, none are at present wise enough to predict.

In subsequently restoring property which should not have been meddled with, the Western Union company, although theoretically carrying out the instructions of the court, could not neutralize the designedly disastrous effect of the actual stoppage of business, and the consequent discredit which had been thrown upon its competitor's capacity for reliable telegraphic transmission. The very fact that the order of restitution was so readily complied with, is sufficient to prove that the seizure was unjustifiable; but the object aimed at—the crippling of a competing system—was effected, and the lapse of time will be depended upon to obliterate all permanent traces of the outrage.

DISTRICT MESSENGER SERVICE.

It will doubtless be a most surprising, not to say incredible piece of information to the New York public to be told that the supply of boys is actually running short. The gentleman who advertised a few days ago for an office boy at four dollars a week, apparently did not think so when upon his arrival at his place of business he found the entrance blockaded with applicants of all grades. It has been innocently supposed that the competition between the various district companies would naturally tend to bring about an improved service. This, however, does not by any means appear to be the case. Not only is the visible crop of suitable boys absorbed, but the constant demand for their services by rival companies relieves them from any serious apprehension as to the loss of employment in case of receiving what is technically known as the "bounce." It has long been observed that boys do not yearn for positions on the district messenger force. The struggle for existence, however, compels many parents to place their offspring in this service, for the simple reason that no more satisfactory opening presents itself. They are forced to submit to a more or less rigid discipline, as for obvious reasons, a congregated mass of New York boys can be controlled in no other way.

A thoroughly organized messenger service should be equal to any emergency, but the experience of the public in some of the New York districts proves that such is not the case, but that on the contrary there is much room for improvement.

Business men entirely dependent upon this source for messengers, naturally become impatient, when after repeated calls for perhaps an hour without response, they learn that because of the prevailing heat, the demand for messengers is unusually large, and that there are not boys enough to supply the demand. It might also be added that those actually in service cannot move so rapidly in hot weather, and the fact that by the arbitrary stupidity of the management they are obliged to be clothed in full winter uniform, with the thermometer at + 100° does not tend in the slightest degree to accelerate their footsteps. The prevailing low rates for telegrams by which their number has somewhat increased, together with the modern system of collecting messages by the district boys, compels the employment of a much larger force than was formerly the case. It is difficult to believe, however, that there is no remedy for this state of affairs. If messengers cannot be furnished promptly to collect telegrams, this branch of the service had better be dispensed with at once.

The business public never demanded this innovation; it is merely one of the outgrowths of fierce competition for public patronage. Having become accustomed to rely upon it, delays and failures which occur more or less frequently are a fruitful source of vexation and annoyance. Sufficient attention has already been paid to cheapening the telegraph service, but we would respectfully suggest that its improvement is still worthy of consideration, and would form a fine field of operations for some company. Every experienced telegraphic manager knows full well that the weakest point in the whole telegraph system is the messenger service. This is not a matter for scientific treatment, but it certainly is of sufficient importance to demand the application of practical common sense. But we may suggest that there are plenty of executive officers capable of managing men, who would fail ignominiously in coping with the ingenious insubordination of the small boy.

DOMESTIC ELECTRIC LIGHTING.

One of the most promising fields for electric lighting remains comparatively undeveloped. We have heretofore referred to the installation of isolated plants for incandescent lighting in factories, stores, hotels, and large apartment or office buildings. In most of these establishments steam plants are necessary for elevators, power, and heating, so that the additional care and expense of an electric lighting system may be provided for without proving a serious burden.

The lighting of country villas and suburban residences is, however, a problem more difficult of solution. Such an installation is extremely desirable in many cases, as the unquestionable perfection of the light from a sanitary point of view, would insure its adoption in numerous instances, at even double the cost of gas. A very important advantage is the exemption from the danger attending the use of friction matches. Where incandescent systems are operated from central stations, of course it is preferable to derive the light from that source, but there will always be a vast number of residences outside those districts which are now dependent upon illuminating oil from necessity rather than choice. A large proportion of these consumers would willingly adopt the incandescent light if it could be supplied at a reasonable price without annoyance. In England, Mr. Preece has adopted a storage battery system, supplied by a dynamo, the power being derived from a gas engine. Such an arrangement, however satisfactory to an expert, is rather too complicated for an ordinary householder. Storage batteries supplied by dynamos, and

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operated by a company properly organized for such service, have been introduced in Cheyenne, and probably other cities. There the subscribers are merely called upon to pay their monthly bills, reserving, of course, the usual privilege of growling at their exorbitance. Right here it may be well to mention that a definite contract based upon a proper estimate of consumption, which experience should teach, would probably provide against those accusations of overcharging which have become chronic among many gas consumers. All private installations of gas, steam, water or electricity, are too apt to be neglected if dependent upon the casual supervision even of experts, who have more important matters to engross their attention. As a flagrant example of this, we have in mind a certain Morse telegraph line connecting the residences of several more or less distinguished electricians, which is not in working order for a continuous month during an entire year.

In providing for a system of domestic lighting such as we have suggested, the question of economy within reasonable limits is not the most important one. Its *general* introduction would of course depend in a great measure upon its cost, but there are very many people who in their homes will have the best, if at the same time it be the safest and the most healthful. A primary battery which will meet all the conditions, is at present the dream of many who are experimenting in this direction, and it is of course possible that some fortunate inventor may hit upon the particular combination leading to successful results.

TELEGRAPHIC ERRORS.

The question of responsibility for errors in telegrams is one which is continually presenting itself, and although telegraph companies universally require their patrons upon filing a telegram to sign a printed agreement to release the company from all liability for damage in consequence of mistake, delay, or non-delivery unless the message be insured, the courts have rendered various and by no means consistent decisions, in suits involving the question of responsibility which have been brought before them for adjudication. Almost every conceivable form of discipline has been devised in the vain hope of preventing operators from making these unfortunate blunders, while on the other hand, the much lauded improvements in duplex, quadruplex and automatic telegraph machinery which have been introduced within the past few years have tended to increase and multiply them. We doubt whether an artisan in any other vocation is so peculiarly situated in regard to the making of mistakes as the telegraphic operator, when he receives, as he necessarily must, by sound alone. In the first place he is often unjustly charged with errors which may have been wholly the fault of the transmitting operator, it being tacitly assumed that the sender follows his copy accurately and cannot therefore go astray. In the second place no opportunity can be afforded him to verify his work. If every operator was allowed to repeat each message back, or to take the necessary time to give it a careful examination after its receipt, the dividends earned by telegraph companies would be few and small, especially at the prevailing rates of service. The modern operator is driven by his distant colleague to copy messages legibly from the dictation of a sounder at an average speed of some thirty words per minute, far beyond that which is even deemed possible by penmen in any other branch of business. Each message as its end is reached is thrown aside for immediate delivery; the only safeguard of the operator is the mental counting of the words as his work proceeds, the number of which must compare with the numerical check. The comparatively few errors which are made by the expert operator, especially after the elimination of those fairly attributable to bad manuscript, of faults in circuits or apparatus, should be entitled to be regarded with leniency, even though it is impossible to overlook them entirely. It is, we think, doubtful, whether any system of discipline, legal punishment, or personal responsibility for damages, however stringently enforced, could be so efficacious as the simple feeling of professional pride, which if carefully cultivated, leads to the most salutary results. It is to be regretted that the gradual degradation of the service during the past few years, by the introduction of a large proportion of less intelligent, and therefore less highly paid employés—which is the more deplorable because utterly uncalled for and unnecessary—is slowly undermining that respect for their calling which is the soundest basis for excellence in the work of telegraphers, as well as all skilled operatives.

REIS vs. BELL.

The *Scientific American*, commenting upon the recent decision of Judge McKennan in the suit against the Western Telephone Co. at Pittsburg, to the effect that the prior decisions of Judges Gray and Wallace must be held to be an estoppel against the hearing of further argument in his court on behalf of the defense upon matters previously passed upon by those judges, although the defendants were prepared to introduce testimony to prove that their invention was substantially the same as that used by Philipp Reis many years prior to Bell's invention, says:

The practical effect of this decision is that the use of the Reis telephone is an infringement of the Bell patent—a position which we have expected the lower courts would sooner or later take, since in no other way can the gigantic Bell monopoly be upheld. The moment justice is done, and the use of Reis's invention be allowed, the patent of Bell will be reduced to its proper rank—that of a subordinate improvement. None of the Bell telephone litigations have reached decision by the Supreme Court. If the latter tribunal deals with the Bell patent in the same manner that it has with other wide reaching monopolies, the claims of the Bell people will, in due time, be greatly modified.

We have no authority to speak for the owners of the Bell telephone patents, but we hazard very little in saying that any person or corporation choosing to engage in the business of making, selling or using the Reis telephone, constructed as Reis constructed it, need not feel alarmed about their business being interfered with by the "gigantic Bell monopoly." The trouble appears to be that the courts are unable to see the justice of permitting the defendants in the case to construct telephones like Bell's. When somebody is enjoined from making and using a Reis telephone, unaided by patented improvements of later date belonging to others, it will be time enough for a scientific journal to assert that it is an infringement upon the Bell patent.

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ARTICLES.

THE ELEMENTARY PRINCIPLES OF ELECTRICAL MEASUREMENT.

BY F. L. POPE.

(Continued from p. 261, Volume iii.)

PHENOMENA PRODUCED BY ELECTRICAL ACTION.

Having now obtained a somewhat definite idea of the characteristics of our units of measurement, we will next consider how they are to be used. We can only perform electrical measurements by observing certain *effects* of the electric current. These effects are exhibited in four different forms, viz., 1, *heat*, 2, *chemical decomposition*, 3, *electro-dynamic attraction*, and 4, *electro-static attraction*.

1. *Heat.*—When the positive and negative poles of an electric generator are united by a conductor presenting an inappreciable resistance, such as a thick wire or bar of copper, through which the current passes, the conductor is not perceptibly heated. If, however, we substitute for the thick conductor a thinner one, or one of poorly conducting material, which offers considerable resistance to the current, such a conductor will become heated during the passage of the current. If the sectional area of the conductor is sufficiently small in proportion to the quantity of electricity traversing the circuit, it may be raised even to a white heat, as we see for example, in the case of the luminous filament of the incandescent electric lamp.

Heat is developed by the oxidation of the zinc in the voltaic battery during the production of a current.

The total amount of heat generated by the oxidation of a given weight of pure zinc is always the same, and is, as we shall hereafter see, strictly proportional to the square of the strength of current, or quantity of electricity which traverses the circuit in a given time, but the heat thus generated may be distributed according to circumstances in different proportions between the battery and the external circuit. The facts as to the quantitative relations between electricity and heat were established by J. P. Joule, of Manchester, England, who carefully collected and measured the amount of heat developed in an electric circuit under known conditions. This method of electrical measurement is sometimes resorted to in practice, but other methods hereafter to be explained, are more convenient for most purposes and are therefore more commonly employed. The instrument known as the *galvano-thermometer* is based upon this property of the current.

2. *Chemical Decomposition.*—When an electric current traverses a compound liquid conductor instead of a metallic one, the conducting liquid undergoes decomposition. This fact was discovered by Nicholson and Carlisle in 1800. Faraday devised an apparatus called a *voltameter*, by means of which he experimentally proved that the quantity of liquid thus decomposed in a given time is strictly in proportion to the quantity of electricity traversing the circuit. The voltameter consists principally of a graduated tube, by means of which the bulk of gas generated in a given time is collected and measured. This instrument will be hereafter described. It is found very useful in certain classes of electrical measurements.

3. *Electro-Dynamic Attraction.*—When an electric current traverses a conductor situated in the vicinity of, and parallel to a freely suspended magnet (such for example as the needle of an ordinary compass), lying in the magnetic meridian, the magnet will be deflected from its normal position in the plane of the magnetic meridian, and will tend to assume a position at right angles to the plane of the conductor conveying the electric current. This fact was discovered by Oersted in 1820. The greater the strength or magnitude of the current, the more nearly will the needle approach a position perpendicular to the conductor. It is found that when proper precautions are observed, the angles of deflection of a magnetic needle, when thus under the influence of a voltaic current, are strictly proportional to the strength of the current or the quantity of electricity passing. Such a needle, therefore, becomes one of the most convenient instruments for measuring or comparing the effective energy of different currents, and forms the essential principle of the *galvanoscope* or *galvanometer*.

When two electric currents traverse two parallel conductors in the same direction, they mutually attract each other, but if the direction of the respective currents is contrary, they repel each other. This was Ampère's discovery, and was made by him shortly after Oersted discovered the action of the current upon a magnetized needle. This action may be readily demonstrated by a simple apparatus known as Roget's vibrating spiral. A copper wire about 0.7 mm. in diameter (No. 22 B. W. G.) is coiled into a spiral or helix of about 30 turns of 25 mm. (1 inch) diameter. Its upper end may be fastened in a binding-screw or clamp, from which it is vertically suspended, in such a manner that the lower end just dips into a small cup of mercury. If a current of from three to five Grove or bichromate battery cells, or an equivalent current from a dynamo-machine, is made to pass through the spiral by means of the binding screw and the mercury cup, the adjacent convolutions of the spiral are traversed by parallel currents, or what is the same thing, by parallel sections of the same current. The spirals, therefore, mutually attract each other, the helix contracts in the direction of its length, and thus the contact with the mercury is broken and the circuit interrupted. Upon the cessation of the current the coils no longer attract each other but tend to separate by their own weight, thus re-establishing the contact between the wire and the mercury; and this action will be indefinitely repeated. The experiment may be rendered still more striking by introducing a magnetized rod of hardened steel about the size of a lead pencil into the interior of the spiral.[1]

It is obvious that all the actions of electric currents upon one another may be multiplied, as in the experiment just described, by using instead of a single wire, a coil of wire, through each convolution of which the same or a similar current is flowing. Hence a circuit formed of ten convolutions of wire would be acted upon by ten times as great a force as a single convolution traversed by the same current.

Upon this fact is based an instrument for indicating, measuring and comparing currents, called the *electro-dynamometer*, which will hereafter be explained.

If a metallic wire be wound in a spiral or helix around a glass tube containing an unmagnetized bar or rod of iron or steel, and an electric current be then passed through the wire, the enclosed bar becomes strongly magnetic. This experiment was first made by Ampère. It is not necessary, however, that the iron or steel bar should be placed in a tube. It is quite sufficient to wind around the bar a copper wire overspun with a coating of silk, cotton or other non-conductor of electricity, in order to insulate the adjacent convolutions of wire from each other and force the current to pass through its entire length. The action of the current by which the magnetism is induced in the iron or steel, is multiplied by the number of convolutions, so that a comparatively feeble current may thus be made to produce a powerful magnetizing effect. So long as the current continues to flow the enclosed bar remains magnetic and exhibits all the phenomena of an artificial magnet, such as the capacity to attract other pieces of iron or steel, and even of inducing magnetism in such pieces when in contact with or in close proximity to itself. Such an apparatus is one form of the *electro-magnet*. If the bar thus endowed with magnetism is of hardened iron or steel it will retain a considerable amount of magnetism even after the current ceases to flow, but if of annealed or soft-iron the magnetism disappears instantly upon the cessation of the current and

1. Atkinson's Ganot's Physics; 10th ed. p. 764.

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the bar becomes neutral as before, scarcely a trace of remaining magnetism being perceptible.

The power of the electric current to thus induce magnetism in soft iron is, from a practical point of view, its most useful characteristic. It is this quality which renders possible its adaptation to a vast and rapidly increasing number of useful purposes in the domain of science and the arts.

The *magnetometer* is an example of a measuring apparatus based upon this property of the electric current.

4. *Electro-Static Attraction.*—If a piece of glass and a piece of gutta-percha or other resinous material are rubbed smartly together, they will be found to manifest a certain attraction for each other, and it will also be found that either the rubbed gutta-percha or the rubbed glass is capable of attracting any light body in its vicinity. This form of electrical attraction was observed by the ancients, and was perhaps the earliest electrical phenomenon which attracted notice. If a voltaic battery be formed of a large number, for example 500 or 1,000 elements, and has its poles brought into the immediate vicinity of each other without being actually united by a metallic conductor, and a light body, as a pith-ball, be freely suspended from a support in electrical connection with each of the two poles, the respective pith-balls will be found to mutually attract each other. This effect is assumed to be due to an accumulation of positive electricity at one pole of the battery and of negative electricity at the other pole, both being in a static condition. The attraction manifested between bodies thus oppositely electrified is termed *electro-static attraction.*

This attraction is utilized in the construction of certain kinds of apparatus for electrical measurement, such for example as the *electroscope* and the *electrometer*, which are employed to indicate the presence of a static charge of electricity or to determine its potential.

(*To be continued.*)

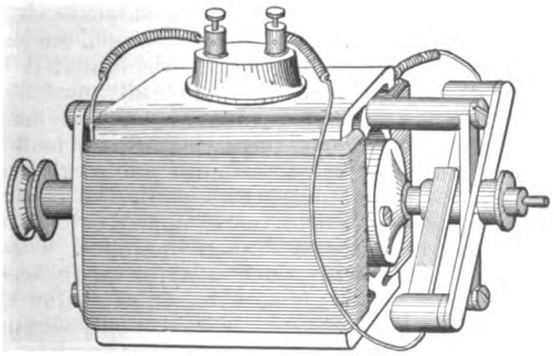
ELECTRICAL MOTORS AND THEIR CONSTRUCTION.[1]

BY JOHN E. CHASTER.

(Concluded from page 128.)

The suggestion was made to me to use for my motor a clumsy imitation of the Siemens armature form, of strips of iron made in the shape of a cross. This was experimentally tested, but with very unsatisfactory results.

I trust that amateurs will be able to construct a motor from my description in a satisfactory manner. When correctly fitted up the motor will be found to be of very high efficiency. The making of the patterns for the castings is very troublesome and perhaps beyond the skill of many amateurs, so that it may be advisable to get the castings made at a regular shop. These should be well carburetted and thoroughly annealed, and if cleanly made will require but little labor in fitting.



The engraving of the motor given herewith is from a photograph taken from the finished machine, and in combination with the drawings already given, will serve to make the construction and fitting quite clear.

1. *English Mechanic* (abridged).

[The directions for the construction of the above motor has awakened considerable interest among our readers, one of whom has kindly furnished details of a similar motor constructed by himself. His description is followed by directions for preparing a cheaper bichromate solution which will be found useful.—EDITOR.]

MOTOR CONSTRUCTED BY E. F. COLE.

The following is a partial description of the electric motor constructed by the writer, which is referred to in letter 33, page 226, of the ELECTRICIAN AND ELECTRICAL ENGINEER. The reader is presupposed to have some knowledge of the subject, as the description relates principally to such parts as may vary somewhat from the usual mode of construction. The dimensions may be obtained from the accompanying cuts which are half size.

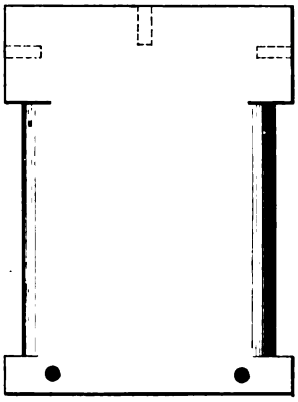


FIGURE 1.

FIGURE 2.

The field-magnet is of cast-iron, of the form shown in figures 1 and 2; figure 1 showing a side, and figure 2 a sectional view of one-half.

Figure 3 shows the form of the armature, which is of *wrought iron*, thoroughly annealed. Figure 4 represents the same after winding, and figure 5 shows a cross-section of the armature and field-magnet. It will be seen

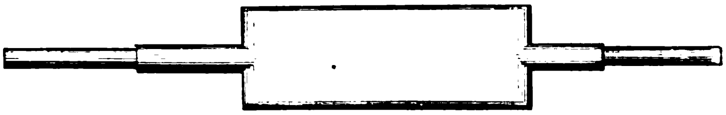


FIGURE 3.

from fig. 5 that the curve of the pole extensions and the circle described by the armature are not concentric; the former forming arcs of a larger circle.

The bearings for the armature may be of any convenient form, providing they are well trued up, and rigidly secured to the magnet. This is quite an important point, as the armature should rotate with the least possible variation. A cap of wood or vulcanite, *b*, fig. 5, may be secured to the top of the magnet, to which the binding posts can

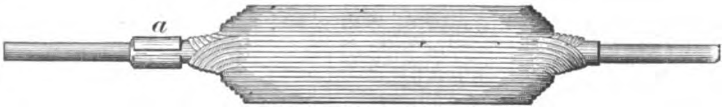


FIGURE 4.

be attached. The armature contains five layers of No. 18 wire (American gauge), the ends of which are attached to the commutator, *a*, fig. 4, in the usual manner. The connection is not shown in the cut.

As the wire is wound on, it is cemented together with shellac or a varnish composed of sealing-wax and alcohol. The field-magnet is wound with three layers of No. 16

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wire, and the coils of the two limbs so connected that the current will divide between them.

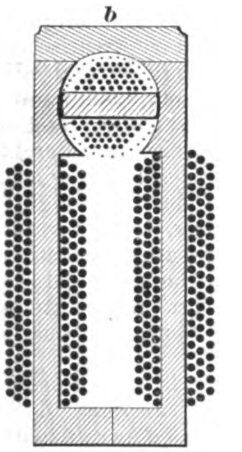

FIGURE 5.

This gives double terminals, one of which is connected with one of the binding posts, and the other with one brush of the commutator, the remaining post and brush being connected with each other.

It is, perhaps, hardly necessary to state that the commutator must be so arranged as to reverse the current when the poles of the armature are within the hollow of the magnet, as in fig. 5.

Thus arranged, the motor is adapted to a battery of six or eight bichromate cells, containing zinc plates 3x6 inches.

E. F. COLE.

ARKWRIGHT, N. Y., July 18, 1885.

A NEW BICHROMATE SOLUTION.

THERE appears to be unusual interest shown at the present time in primary batteries adapted to electric lighting and motors, especially for experimental purposes. As yet, no form of battery discovered possesses so many desirable qualities as the various forms of carbon, actuated by a solution of bichromate of potash. It has now been thoroughly demonstrated by practical experience that the bichromate of soda is in every respect a perfect substitute for the potash, while the price per pound is two cents less. Its principal use heretofore has been as a fertilizer. Not being in the form of a crystal, it dissolves more readily, and does not crystallize on the carbon plates, when the battery is overworked. It has now been regularly used for two months by the Gold and Stock Telegraph Co. in this city for driving the stock printers. About 8,000 cells of the Fuller form of battery are used in this service, forming probably the largest plant of the kind in the world.

The following are the proportions used for the ordinary bichromate solution by Mr. M. Breslin, the chief batteryman, who has devoted much attention to obtaining the best possible results: Three gallons of water, 15 pounds sulphuric acid, five pounds bichromate of soda, making six gallons of the fluid. He believes that by further experimenting he may be able to produce a heavier and consequently a more enduring solution. As the bichromate is the most expensive ingredient in the maintenance of such batteries, the satisfactory performance of a cheaper article should lead to its general adoption. Our readers may be assured that the adoption of this solution by the Gold and Stock Telegraph Co. is the most thorough endorsement that could be given it, and it may be used with confidence in every case where required.

ATMOSPHERIC ELECTRICITY.

BY LUCIEN I. BLAKE, PH. D.

IN the May number of "THE ELECTRICIAN AND ELECTRICAL ENGINEER," the president of the N. Y. Electrical Society has appended some remarks of his own to a paper upon Atmospheric Electricity, presented by myself before that Society. Through absence at the meeting when the paper was read, I had no cognizance of the remarks until they appeared in this journal. Although the theories in regard to atmospheric electricity, mentioned in the remarks, are long since known to scientists to be based upon old experiments demonstrably imperfect and in general incorrect,[1] and consequently need no new refutation, still since the paper is misrepresented, through confusion in the scientific distinction between *convection* and *conduction*, on the part of the president of that society, it is well to call attention to these remarks.

The object of the paper, as stated in it, was not to discuss *all* the theories as to the cause or causes of atmospheric electricity advanced in times past and present, but solely to show, 1st, the general conclusions now accepted as regards the production of electricity by *quiet evaporation* (the only kind of evaporation occurring in nature) and, 2d, *that one of the most plausible existing theories is based upon an erroneous principle.* Hence the charge of "one-sidedness" in presentation is not relevant.

The theory of atmospheric electricity which is proposed in the remarks as satisfactory, is that of electrostatic induction. The earth's negative charge induces electricity in the cloud masses above. We shall see this cannot be a sufficient cause of the immense quantities of electricity in the atmosphere. If the potential at any point in the atmosphere, say even 15 ft. from the earth, is measured by means of Sir Wm. Thomson's water dropping collector, as employed for the last ten years at the Kew observatory, London, and as now employed at Johns Hopkins and Harvard, or even by a Volta flame, the indications will show really the difference of potential between that point and the earth's surface, or will thereby determine the quantity of electricity upon the earth's surface at the place of observation. Now observations show[2] that the variations which occur in the electrical density on the earth's surface are so rapid and so enormous that no other cause than the inductive action upon the earth of the electrified cloud or air masses above is in any way sufficient to account for them. In fog or mist, when according to the remarks, this conducting mass should be negative, it has always been found to be positive. If these observations should be extended over the whole earth, and there is no reason for presuming that they would not indicate everywhere similar fluctuations, the atmospheric electrification, which according to the remarks is the *induced* charge—must enormously surpass the earth's charge,—or the induced exceeds the inducing electrification, which is absurd.

To return to the paper. As regards the production of electricity by evaporation, the subject has been so thoroughly discussed, the errors, due chiefly to the imperfect instruments of early experimenters, such as Volta, Pouillet, Saussure, shown so indisputably by such authorities as *Riess Reibung's Elektricität*, 2, p. 407 & 491, 1853, *Philos. Mag.*, 13, p. 398, 1882, *Wiedemann's Lehre von der Elektricität*, vol. i., p. 240, 1884, the highest and most recent text-book authority in Germany, that it is surprising that a sufficient source here of atmospheric electricity is longer entertained by any minds. Helmholtz, by the way, has never made any investigations upon the production of electricity by evaporation, though so stated in the remarks.

But the most important part of the paper, the *disproving of an hitherto believed natural law*, the president has entirely failed to grasp, because he has confused conduction with convection. The paper does not deal with conduction through vapory matter. That subject is well understood by all physicists. The remarks about the conductibility of watery vapor hence have no bearing at all upon the subject. The paper simply proves that vapor of any temperature ascending from an electrified surface is incapable of being the bearer of any electricity—of carrying any electricity away from that surface with itself. Such a process would be *convection*. Conduction on the other hand, would be the passage of electricity through the vapor. The value of establishing the electrical neutrality of vapor ascending from an electrified surface lies here, in so far as atmospheric electricity is concerned. If we can only account for the original electrification of minute vapor particles in the air, then will be rendered plausible Tait's theory[3] of the

1. Daguin, *Traité de Physique*, Tome III., p. 272.

2. Windsor and Kew Observations, Proc. Roy. Soc., June, 1863, Jan. 1865. Trans. Roy. Soc., Dec. 1867.

3. *Nature*, Sept. 9, 1880, p. 436.

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increase of potential by agglomeration of these particles into drops to form clouds and rain, according to the law of the dependence of the potential of a sphere upon its radius. Granted the ocean's surface is statically electrified ; granted the electrical *convection* by the vapors ascending from that surface, the electrification of the vapor particles in the air is accounted for, and the enormous increase of potential with the sudden condensations explained. The paper proves the intermediate step of vapor convection which is essential to this theory, as well as to those of Franklin,[4] E. Becquerel[5] and De la Rive[6] is false.

DEATH OF PROFESSOR FLEEMING JENKIN, F.R.S.

Among the eminent scientists who have devoted their best work to the thorough investigation of electricity and its application to useful purposes, perhaps none have left a more satisfactory record than the late Mr. H. C. Fleeming Jenkin, Professor of Engineering in the University of Edinburgh. He had recently devoted considerable attention to electric locomotion, and just previous to his death had been engaged for a short time at London in the development of inventions devoted to that work. He returned to his Edinburgh home to undergo a slight surgical operation, which was followed by blood poisoning, finally terminating fatally on Friday, June 12. He was the only son of Captain Charles Jenkin, R.N., and was born at Stowting Court, Kent, in 1833. At the age of 13 he attended school at Frankfort. A year later he went to Paris and remained during the revolution of 1848, subsequently graduating at the University of Genoa, where he obtained the degree of M.A. His first experience at practical work was at a locomotive shop in Marseilles, which was followed by a three years apprenticeship with Sir W. Fairbairn, of Manchester. He entered the service of Messrs. Newall, at Birkenhead, in 1857, where the first Atlantic cable was then being manufactured. Being entrusted with their principal engineering and electrical work, his future career was determined by his experience while so engaged, and the acquaintanceship with Sir William Thomson, which he formed at that time, contributed materially to his subsequent success. After participating in the manufacture of the Atlantic, Red Sea, and several Mediterranean cables, also in the laying of some of the latter, he formed a partnership with Mr. H. C. Forde in 1861, and engaged in the business of civil engineering at London. It was at about this date that under the encouragement of his friend Sir William Thomson, he became identified with scientific literature, his first paper being on "The Transmission of Electric Signals Through Submarine Cables," which was presented to the Royal Society in 1862. In conjunction with Sir William Thomson and the late C. F. Varley, he became interested in the invention of cable instruments, the patents for which proved extremely valuable. In 1866 (being then a Fellow of the Royal Society) he was elected to the Professorship of Engineering in the University College, London. His most excellent work during his two years occupancy of this chair led to his selection for a similar position with the University of Edinburgh in 1868. In accepting this professorship he was compelled to relinquish his association with Mr. Forde. Being a highly skilled and enthusiastic teacher he soon attracted to his class many bright and able young men, whose subsequent professional success has proved the efficacy of his methods. His mental activity however, did not permit his confinement to the simple routine of his duties as a professor. He became a prominent member of various scientific societies, while his signal ability led to his frequent engagement as consulting engineer and electrical expert, serving also in a public capacity as assessor at the courts.

4. *Mem. Cour. de l'Acad. d. Belg.* XVI., 1843.
5. *Comptes Rendus*, 1856, t. 42, p. 661.
6. *Traité de l'Electricité*, 1858, t. III., p. 190.

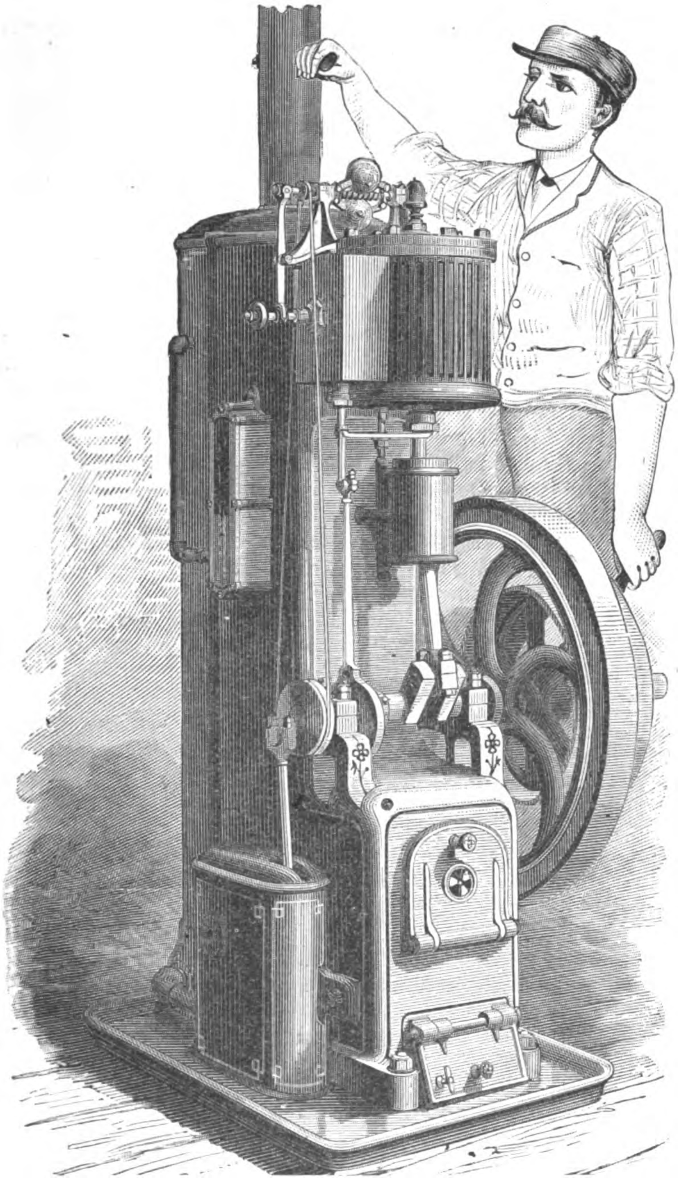
His literary work although quite extensive was by no means confined to electrical subjects. His principal text-book, and the last one, entitled "Electricity and Magnetism," is perhaps the best existing elementary treatise on the subject, and has already passed through several editions and been translated into various foreign languages. Many of his essays were published in the *North British Review*, and among the topics treated by him at different times, were evolution, education, economics and hygiene. He was one of those men of broad intellect, thoroughly known only to his most intimate friends, who, for the most part, were specialists in literature and art, rather than devoted to such subjects as formed the principal occupation of his life. An accomplished linguist, litterateur, critic, metaphysician and sportsman, he appeared equally familiar with almost every subject.

In 1882 he became quite interested in a lecture illustrative of Professors Ayrton and Perry's absolute block signal system, and made a proposition to coöperate with those gentlemen for the development and perfection of a method of overhead electric transportation, to which he ultimately gave the name of "telpherage." This was eventually followed by the organization of the Telpherage Company, of which he was a director, and after a long series of experiments, a practical telpher line was undertaken for carrying 250 tons of clay per week for the Sussex Portland Cement Company. The manufacture of the electric motors, and the construction of the line for this purpose was occupying his attention, when he returned home from London for the last time. In the development of this system his prolific inventive genius was apparent, as was shown by his many patents, which experience taught him were necessary to overcome the many obstacles encountered. Bridge work, hydraulics, methods of mechanically transmitting power, and heat engines were also at various times improved by him. He won many titular distinctions, being an L.L.D. of the Glasgow University, and an honorary member of the Société Professionelle d'Hygiène of Paris. In 1859 he married the only daughter of the late Alfred Austin, who survives him. He also leaves three sons, the eldest of whom, Austin F. Jenkin, has achieved distinction at Trinity College, Cambridge.

THE DAVEY SAFETY ENGINE.

This engine, which is perhaps more appropriately designated the vacuum motor, was invented by Henry Davey, a prominent English mechanical engineer. It is intended for use where hitherto gas and hot air engines have been looked upon with much favor on account of their freedom from the hazard which attends the use of the ordinary steam engine, unless cared for more systematically than is frequently the case. As its principle, although not entirely new, is practically adapted for actual service, and secures absolute safety, the motor deserves careful investigation. While the use of steam is required to operate it, the motive power is derived, not from its pressure in a confined vessel, but from the production of a vacuum by condensation of the steam at ordinary atmospheric pressure. The only function of the steam, therefore, is to expel the air, when upon condensation a vacuum is produced, and the consequent atmospheric pressure moves the piston. There is absolutely no pressure whatever in the generator, and consequently no danger of explosion under any circumstances. Condensation of this low pressure steam is effected by means of a surface condenser, kept cool by water. Where access can be had to an aqueduct water service, the condenser is placed in the upright iron pocket shown in the cut, at the back of the engine. To this a stream of water is led through a pipe from $\frac{1}{8}$ to $\frac{1}{2}$ an inch diameter, according to the size of the engine. The water enters at the bottom and rises to the top, where it passes off through an overflow. In case running water cannot be

had, the condenser may be placed in a wooden tank at any convenient place within a few feet of the engine, to which connections are made by means of pipes. The consumption of water is confined to the amount required to supply the generator—about three gallons per h. p. per hour—which is evaporated, condensed, and discharged in the form of distilled water from a little pipe at the side of the engine. If desirable this water may be saved and permitted to cool, when it may be returned to the tank and used over and over again. Arranged in this way there is no actual consumption of water, and the tank once filled will last for months without a fresh supply. The



THE DAVEY SAFETY ENGINE.

engine is double-acting, a vacuum being formed alternately at each end of the cylinder. The cylinder, piston-head and rod are made of bronze, and require no oiling, the low steam used being moist, and in itself a sufficient lubricant. Another advantage arising from the use of bronze is that in case the engine stands idle for any length of time, it suffers no deterioration from rust. The economy of fuel is considerable, as the quantity of water consumed is less than half that required in running an ordinary steam engine of equal power, while the water is raised to but 212°, instead of 300 to 340°, as in a high-pressure boiler. The comparatively low temperature causes but little precipitation of lime in the generator. The water level is constant and unvarying, the supply being automatically regulated, and even should it fluctuate, no danger can ensue. It has no safety valve, no exhaust, no steam gauge, no gauge cocks, no boiler pump nor injector, most of which devices require careful attention in the ordinary steam engine. Any class of fuel may be used which will go into the fire-box—either hard or soft coal, wood, coke, or cobs; petroleum or gas may be used by a proper arrangement of pipes in the fire box. The cost of ordinary fuel will not exceed one cent per h. p. per hour, and it requires no more attention than a domestic stove. There being no pressure to provide against, the generator is constructed of cast iron, and cannot be readily burned out or caused to leak. It will suffer no injury if allowed to run perfectly dry with a fire burning in the furnace.

Among the advantages claimed for this motor over the high-pressure engine, are the following: Economy in fuel; exemption from injury arising from careless firing; no possibility of explosion under any circumstances; no necessity for skilled attention. Its superiority over the gas engine is that its first cost is only about half as much, while the cost of fuel is but about one-fourth. Its mechanism is much simpler and less liable to derangement. Its consumption of water is no greater, and the air is not vitiated by the discharge of unburnt gas and the products of combustion.

The working parts being in all respects the same as a steam engine, it is equally durable, and the weight ranges from 700 to 1,800 pounds. The motor may be started in from 10 to 20 minutes after lighting the fire. In buildings heated by steam, it may be attached to the radiator in any room, and in such cases, of course, no fire is required in the generator, the engine being controlled by the valve connecting it with the steam coil. They may be run at a speed of from 150 to 200 revolutions per minute, and are at present constructed in sizes from one-half to four h. p. There is no mechanical obstacle to their being made of a larger size, but as in such cases the amount of machinery driven will in most cases require skilled attendance, it is not likely there will be sufficient demand to warrant the manufacture of a larger size. This motor appears to be admirably adapted for small electric lighting plants, experimental laboratories, workshops, and business houses. It is quite extensively used in Great Britain and France, and as its merits become known will doubtless find a large field in the United States, where it is built under license of the patentee, by Chas. P. Willard & Co., of Chicago, Ill.

SPARKING DISTANCE AND DIFFERENCE OF POTENTIALS.

PROFESSOR G. C. FOSTER, read a paper before the Physical Society on the "Difference of Potentials required to give Electric Sparks in Air." The sparks were taken between two brass balls 1.35 centimetres in radius, and the electricity was supplied by a frictional machine. The difference of potential was measured by an absolute attracted-disc electrometer, in which the attraction of the disc was weighed by a balance beam and scale pans. The expression obtained was $v = 102d + 7.07$, where v = the difference of potentials, and d = the distance in centimetres. For distances up to one centimetre this formula held good, and the experimental values agreed very well with the calculated ones. For longer sparks the experimental values fell short of the calculated ones. It also appeared from these experiments that the maximum electric force required for the passage of a spark between the balls decreased as the distance increased. Thus when the distance was 0.142 centimetres, the electric force was 154.76, when 0.497 centimetres, it was 131.66, when 0.9 centimetres, it was 138.57, showing that after reaching a minimum, the force rose again. These results are very remarkable.

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AN ELECTRICAL STANDARD FOR MEASURING LIGHT.

The arrangement of an incandescent lamp for use as a standard light for photographic purposes has been the subject of a series of experiments by Thomas A. Edison and his assistant, John Ott. The problem of obtaining a uniform current and a steady light from a variable battery with lamps of different resistances has been solved, and we copy from the *Scientific American*, a description of the apparatus.

During the past winter months the officers of the Society of Amateur Photographers, of this city, undertook to invent or provide some form of standard light which could be depended upon, to be used in testing the sensitiveness of different brands of gelatino-bromide dry plates. It occurred to them that possibly Mr. Edison might devise a uniform electric light, the actinic qualities of which, it was well known, would be invaluable for the kind of work to be undertaken. The strength of the light required was to be equal to one c.p. When the matter was first introduced it was thought that there would be no difficulty in obtaining a means of accurately measuring and controlling the resistance of such a small lamp, if a battery was employed.

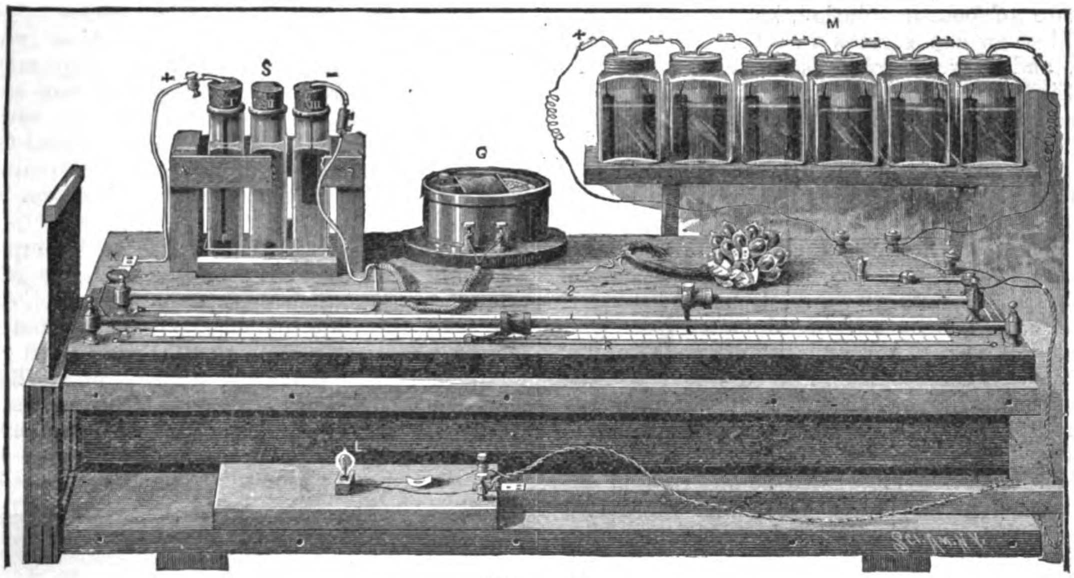

FIGURE 1.

The original plan was to interpose a known resistance in the main circuit with the lamp, which could be varied, and also an ampèremeter or a voltmeter for measuring the variations of the current; but, after a large number of experiments, it was found impossible to make an instrument delicate enough to obtain accurate measurements.

Mr. Edison then turned his attention to the utilization of the electrical compensation balance invented a few years ago by Prof. Poggendorf, which is generally recognized as being the most delicate method of measuring the electromotive force of batteries, and at the same time has the advantage of being entirely free from any detrimental polarization. In this method the currents from two batteries are so balanced by the insertion of a variable resistance that, if a galvanometer is inserted in the circuit, no traces of a current can be perceived.

The arrangement as shown consists of a standard constant battery, a galvanometer, a key, a rheostat or resistance wire in two sections, two parallel brass rods arranged directly above each section of the wire, provided with adjustable collars, which connect the bars to the sections of wire, and a switch, all fixed upon a base which rests upon a photometric testing box. Within the latter, supported upon a sliding board, is the standard electric lamp.

Hinged to this board is a long wooden rod, which when the side of the box is closed, as it is intended to be for actual work, permits the operator to move the lamp at the open end to different distances from the sensitive plate, held in a plate holder slide, shown at the opposite end. The lamp is connected by flexible cords to the binding posts leading to the main battery and one of the sections of the rheostat wire. The apparatus is intended to be used in the photographic dark room. The cell of the standard battery, S, is the standard by which the electromotive force of the Fuller, or main lamp battery, M, is measured. The battery, S, which is comparatively new, is a modification of the well-known Daniell battery. It is so constructed that the fluids cannot become disturbed or mixed through any slight jarring. It consists of three square bottles, 1¼ inches square by 4½ inches high, with a neck ¾ of an inch in diameter by 1 inch long, securely clamped together with metal screw rods at the top and bottom, and held in an upright position by a light wood framework, as shown in the engraving. In the upper part of the adjoining sides of bottles I. and II. is drilled a small hole ⅜ of an inch in diameter, and in the lower part of the adjoining sides of bottles II. and III. are similar holes, all arranged to correspond with each other. A soft rubber washer separates the bottles at the holes, making a water tight joint, and also acting as a support to hold in place a thin film of gold-beater's skin, through which the liquids must pass by the process of endosmose and exosmose, from one bottle to the other.

All of the bottles are filled with a dilute solution of sulphate of zinc; within bottle I. is placed a piece of sulphate of copper about the size of a pea, which changes the solution to a blue color; the copper electrode at the bottom is connected by an insulated wire, which passes through the cork to the back of the key, K. At the bottom of bottle II. is a small chunk of zinc, which collects any deposit of copper, should any pass through from bottle I. In the top of bottle III. is suspended the zinc electrode, which measures about 1½ inches long by ¾ wide and ⅛ thick; its conducting wire as shown passes directly to the galvanometer, G.

It will be noticed this arrangement gives a very constant battery which cannot polarize, as each electrode is completely isolated, and the separation of the bottles with the gold-beater's skin also prevents an easy mixture of the solutions. Each electrode is kept immersed in a solution favorable to retain it in perfect condition.

The main or Fuller battery, M, has been somewhat modified, but consists of a zinc electrode inserted in a porous cup, in which has been placed a teaspoonful of mercury and a dilute solution of sulphuric acid and water. In the glass jar are four carbon rods about one inch square ar-

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ranged to fit in each corner of the jar, connected by a ring of wire at the top to one conducting wire, which passes out through the top of the cell. The jar is filled with the

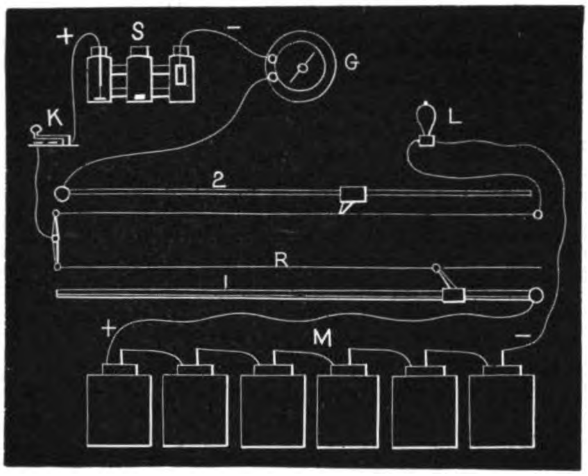

FIG. 2.—DIAGRAM OF CIRCUITS.

usual bichromate of potash solution, known as electropoion. A metal screw cap secures a rubber cover to the top of the jar, and thereby prevents the evaporation of the solution. Six cells are employed, and are plainly seen, located on a shelf at the right, in fig 1.

The amount of resistance inserted in the series is a trifle more than the resistance of the lamp while hot, and consists of a length of 5½ feet of german silver wire $\frac{11}{1000}$ of an inch in diameter, divided into equal sections connected together at one end, as seen in the diagram of fig 2, near the key, K, by a metal link. One section lies upon the millimetre scale parallel with and directly under brass rod No. 2; the other also lies on the board under brass rod No. 1. The section of resistance wire under rod No. 2 is electrically connected thereto by a hinged metal pointed foot and adjustable collar, which may be adjusted to any point on the rod over the millimetre scale, and is secured by a set screw. The position of this collar is never changed except when a new lamp is to be inserted in the circuit. The section of resistance wire under rod No. 1 is electrically connected to the latter by a sliding collar provided with a spring, at the end of which is a grooved brass wheel about $\frac{5}{8}$ of an inch in diameter, which bears directly upon the wire.

In the diagram, fig 2, the arrangement of the apparatus will be seen more clearly. S represents the "standard battery," G the galvanometer, No. 2 brass rod with fixed collar, No. 1 brass rod with movable collar, R resistance wire, which also connects with wire under rod No. 2, K key in the circuit of standard battery, L the electric lamp.

In order to intelligently understand the operation we will detail the two different circuits of the batteries.

The circuit of the Fuller battery, M, is from the positive or carbon pole of the battery to brass bar No. 1, see fig 2, through the collar, spring, and wheel to the german silver wire, R, to the lamp, L, and then back to the negative or zinc pole of the battery. It will be seen that by sliding the collar on rod No. 1, the amount of resistance in this circuit is easily increased or diminished.

The circuit of battery S is from the positive or copper pole through the key, K, to the resistance wire, R, thence through the pointed foot and fixed collar to brass bar No. 2, through the galvanometer, G, and back to the negative or zinc pole of the battery.

In the lamp circuit a switch is inserted for turning the current on and off when testing.

It will be noticed that there is a section of the resistance wire, R (the amount between the end connecting with key, K, and the pointed foot under rod 2), through which the current from each battery flows; and although the current from the main battery, M, has a circuit independent of the galvanometer, it is in this section of wire that both currents are brought into juxtaposition and the electromotive force of the main battery compared with that of the constant battery, S. The variation is at once noticed on the galvanometer, and is easily regulated, as will be hereafter described.

In operating the lamp, the switch in the lamp circuit is first turned on, then the key, K, is pressed, which brings the current of the standard battery, S, into opposition to the current from the main battery, through the galvanometer, G. If the electromotive force of the main battery is too weak, the needle of the galvanometer will be sent to the right of zero a few degrees by battery S; but such movement is at once overcome by diminishing the resistance in the main circuit through the sliding of the collar on rod No. 1 toward the left, in the direction of key, K. As quickly as the resistance is cut out by this movement, so is the needle of the galvanometer forced back to the left until it reaches the zero point; then the batteries are exactly balanced, and the light obtained is equal to that of a standard candle; at this zero reading we have also a constant number of volts of electromotive power.

A bunch of 20 lamps accompanies the apparatus, and may be seen resting upon the base board near the galvanometer. Although all of the lamps may possess the same electrical resistance, they will not emit an equal amount of light, hence in inserting a new lamp it is necessary to locate the hinged pointed metal foot under the brass rod No. 2 at a different point on the millimetre scale, to correspond with the number marked on the label attach to each lamp.

The mode of testing the c.p. of each lamp is to first set the hinged pointed foot arbitrarily at some number on the millimetre scale, then to turn on the switch of battery, M, and gradually slide the wheeled collar from the extreme right hand end of rod No. 1 to the left until enough resistance is cut out to make the intensity of the light from the lamp equal the light of a standard candle, and at the same time to see that the reading of the galvanometer is zero.

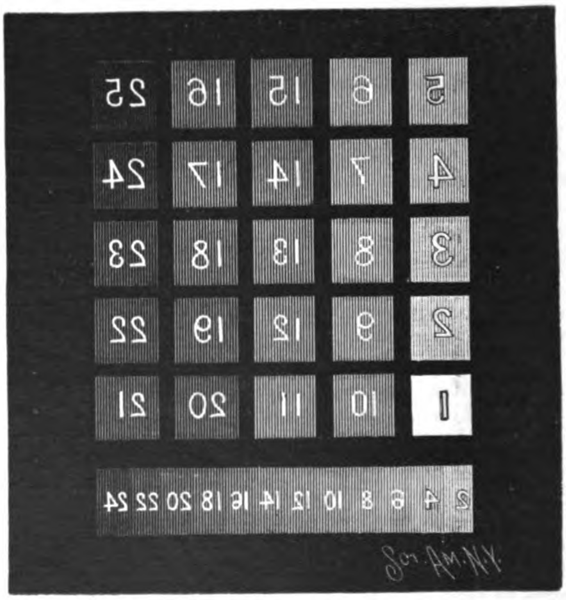

FIG. 3.—SENSITOMETER SCREEN.

The average of a large number of photometric readings is taken to determine the uniformity or the intensity of light emitted from the standard candle.

In view of the differences in the lamps, each one is marked with a special number, which is the separate test, as was shown on the millimetre scale, when it was originally tried, and is to be used when the lamp is put into the main circuit of battery, M, in the manner previously described.

The electrical standard of light thus obtained is far more constant and reliable than that obtained from the standard candle in that all variation of the flame or the uncertainties of the wick are avoided. The galvanometer employed is of the ordinary pattern, having an estimated resistance of about 500 ohms.

As soon as any blackening occurs on the interior of the globe, or even before it, which is due to the gradual destruction of the carbon film from long use, the lamp is removed and a new lamp substituted.

The lamp when employed in making the photographic tests is used but a few seconds at a time, and it is estimated one lamp will, on this account, be good for several thousand tests before the variation of the light will amount to more than one per cent. The simplicity and delicacy by which the resistance is employed to control the current of the variable battery is especially commendable. So delicate is the balance that the resistance of a quarter of an inch of the resistance wire can be read on the galvanometer.

The application of the light in testing the sensitiveness of photographic dry plates may be described as follows: A sensitive dry plate is placed in contact with a Woodbury carbon screen, see fig. 3, such as is used in a Warnerke sensitometer, in a plate holder, and the latter is set into a groove at one end of the testing box, the slide protecting the plate from all light, then being withdrawn, as shown in fig. 1. The electric lamp is then placed so as to be opposite the centre of the screen and 24 inches therefrom. The switch putting the battery, M, in circuit is now turned on, and the light emanating from the lamp is allowed to act upon the screen for 20 seconds; it is instantly stopped by turning off the switch. The sensitive plate is next removed from the plate holder and placed in a developing solution of a given strength for five minutes, and it is then taken out, washed, and immersed in a fixing bath of hyposulphite of soda until the bromide of silver film unacted upon by the light is dissolved out. It is again washed, and when dry is laid film side down upon a piece of white paper. The highest number on the finished negative which can be seen represents the sensitiveness of the plate, and by means of comparative tests the relative sensitiveness of different plates is thus easily determined.

It should be mentioned that the Woodbury screen, fig. 3, is a plate of glass coated with a film of carbon tissue divided into squares, and is made by exposing the sensitized tissue behind another negative screen having similar squares, for a certain number of minutes to the light of the sun, and afterward developed, by dissolving out, with hot water, the parts of the film unacted upon by light. Each square is shaded to be a trifle more dense than its neighbor, and they are distinguished by numbers. No. 1, it will be noticed, is quite transparent, while No. 25 is nearly opaque. The row of figures at the bottom is intended to show in a more compact way the difference in the shading. A sensitive plate showing a reading of 25 will be regarded as having an extreme degree of sensitiveness; and other things being equal, such as freedom from fog in the film, will be excellently adapted for taking instantaneous pictures. One showing 14 would be considered very slow, but excellent for copying or for ordinary landscape work. Nearly two hundred tests have been very successfully made with the lamp, and it forms a valuable addition to the photographic laboratory. In addition to its application to photography, the light may be used for many other purposes, such as comparative photometric tests with other kinds of illuminants. It forms a ready and convenient standard for use in the laboratory, or even for use in gas works, and is an improvement which has long been sought for.

ON THE SIMULTANEOUS DETERMINATION OF THE ELECTROMOTIVE FORCE AND INTERNAL RESISTANCE OF BATTERIES.

BY PROFESSOR W. L. HOOPER.

It is a well-known fact that the fall of potential between points in a closed circuit varies directly as the resistance between those points. This is true even when the resistance includes the seat of the electromotive force of the circuit, as in the electrolyte of a galvanic cell or the armature of a dynamo. Some time ago I devised a method, founded on this principle, of measuring the resistance of batteries (see Vol. III., p. 59, ELECTRICIAN AND ELECTRICAL ENGINEER), but afterwards found I had been anticipated by Kempe. The key that I used has, however, never been described. It is similar to the double key fre-

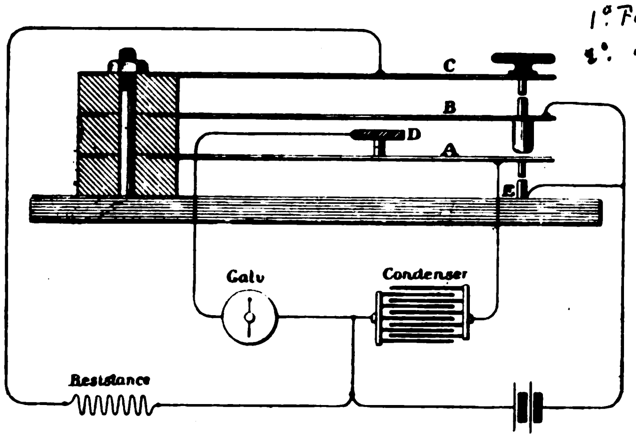

FIGURE 1.

quently used with the Wheatstone bridge, excepting that over the lower arm, A, is a cross-bar, D, in metallic contact with it when the arm is in its normal position. In use, one terminal of the battery is connected to the pin, E, the other to a condenser; the same terminal of the condenser is connected through a delicate reflecting galvanometer to the crossbar, D, the other terminal to the lower arm, A. When the key is pressed, the condenser is charged; when released, the condenser is discharged through the galvanometer, from the throw of whose needle the electromotive force of the cell may of course be calculated.

The poles of the battery are then connected through a known resistance, best approximately equal to the resistance of the battery, to the two upper arms, B and C, and the difference of potential again observed by pressing the key. The known resistance must of course include the contact resistance between B and C.

If E is the electromotive force of the battery, E' the difference of potential between its poles when the circuit is closed, R the internal resistance, and V the known external resistance, we shall have: (see note above)

$$\frac{E}{E'} = \frac{R \times V}{V}$$

whence R is easily calculated.

As the circuit is only momentarily closed, there is no time for polarization to occur; and as the condenser, excepting when the key is pressed, is always short-circuited through the galvanometer, there is no chance for a residual charge to accumulate in it. I have found no method so expeditious and trustworthy; indeed, by it the resistance of a cell is obtained almost as quickly and with but little less accuracy, than that of a coil of wire with the Wheatstone bridge.

Every one who has had much to do with batteries has of course noticed the more or less rapid decrease of current from a cell coupled up with a small external resistance. It has been usual to attribute this decrease of current to the opposing electromotive force of polarization. Now, the current in any circuit is a function of two variables—

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the electromotive force and resistance; and in a battery circuit, when the external is small, variations of internal resistance may be nearly as effective in changing the current as variations of electromotive force itself. In certain cells with which I have experimented, I have felt sure that the decrease of current was not altogether due to polarization, but partly to altered resistance, owing to changes in the composition of the electrolyte. So far as I know, no method has been devised that would enable one to simultaneously determine both electromotive force and internal resistance of a battery in action, and that, too, without appreciably interfering with the arrangements of the circuit. I have, therefore, sought to devise a method that would enable one to obtain a practically continuous record of the electromotive force and internal resistance of a battery during the whole or any part of its entire life.

For this purpose I added another arm to my old key, and placed a cross-bar over each arm, four in all. The key is connected to battery, known resistance, two condensers, and two galvanometers, as shown in figure 2.

On pressing the key, D separates from I, breaking connection between the condenser and galvanometer for obtaining the difference of potential between the poles of the short-circuited battery. The upper arm, D, coming in contact with C, connects the battery and condenser, which receives a charge, but this circuit is at once broken by the separation of C from H. C, descending, comes in contact with the hard rubber button on B, and depressing it, opens the battery circuit through the known resistance. The lower arm, A, is next engaged, and the circuit between the galvanometer and condenser for measuring electromotive force is broken by A leaving the cross-bar, E; the condenser and battery are then connected through K. As the key returns to its normal position, the condenser is discharged through its galvanometer, the resistance circuit again closed, the other condenser once more momentarily connected with the shunted battery, and finally discharged through its galvanometer. The whole operation is completed in a small fraction of a second. Both galvanometers employed by me are Thomson's reflectors of about 6,000

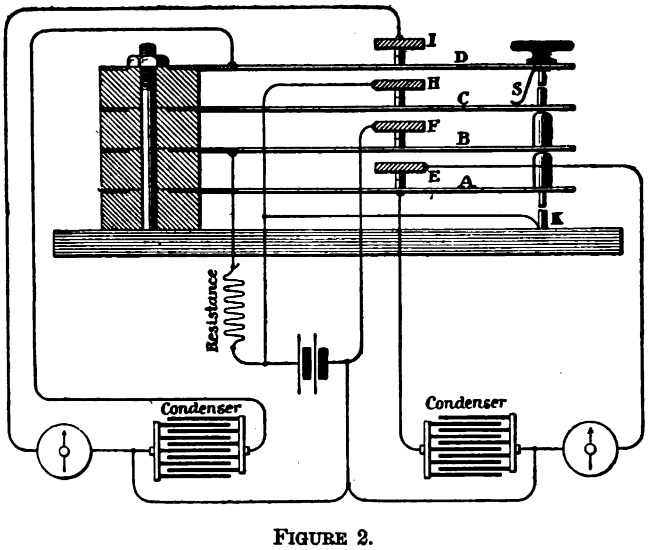

FIGURE 2.

ohms resistance, and are placed 8 or 10 feet apart. The condenser battery and key are usually on the table in front of one of the galvanometers. Two observers are, of course, required. The galvanometers are usually so adjusted that one volt gives 200 or 300 divisions on the scale; this renders the computations much simpler. It would also be well to have the known external resistance some even number of ohms or tenths of an ohm.

A curious difficulty was encountered at first in the use of this key, when it was found that the condenser attached to the upper arm received variable charges for the same difference of potential. After some study and experimenting, the cause of these discrepancies was discovered. It has been explained that the condenser is thrown into circuit with the battery by the upper arm coming in contact with that below it. Now, as the arms are tolerably rigid, it happens that the interval of time between the contact of the two and the separation of the lower, C, from its cross-bar, H, is very short. Hence, as the condenser used was a large one—about 1½ microfarads—there was seldom time

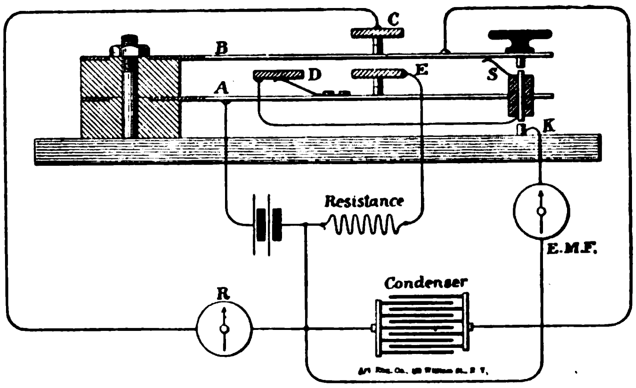

FIGURE 3.

for it to become fully charged. This failure was particularly noticeable with the small standards of electromotive force, the Clarke and plaster of paris Daniell. A piece of watch-spring soldered to the upper arm (as shown at S), so that contact between the two arms was made some time before the lower began to be pushed down, completely remedied the evil, and no further difficulty from the key has been encountered.

Mr. F. S. Pearson, a student in the laboratory, has devised a key necessitating the use of only one condenser, as shown in figure 3. Its action is as follows: The upper arm, B, descending meets the spring attached to the insulated platinum rod at S, which connects the condenser and shunted battery through the cross-bar and spring at D. The spring at S merely serves to obviate the time difficulty mentioned in connection with my key. The condenser now becomes partly charged, and on the battery circuit through the known external resistance being broken at E by the descent of A, the condenser takes its full charge. As the lower arm, A, descends still further, connection between the battery and condenser is broken at the spring, D, and on connection being made between K and B, through the pin, S, the condenser is discharged through the galvanometer, E.M.F. On the return of the arms, connection between the condenser and battery is first established, the condenser taking its full charge; but immediately the resistance circuit is established at E, and the charge of the condenser falls accordingly; connection at S is then broken, and finally the condenser is discharged through the galvanometer, R, from whose deflections the resistance of the battery is calculated.

I append a set of observations with each of two different cells, the Grove and the Orne (bichromate). The known external resistance was in each case .714 ohm. The first column gives the times from the instant of closing resistance circuit, the second and third the deflections of the galvanometer E. M. F., and the volts corresponding to those deflections. The fourth and fifth columns give the deflections and corresponding difference of potential for the other galvanometer. The sixth column gives the deduced internal resistance of the battery for the instant of observation:

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Small Grove Cell.

Time.	E		E′		R
	Divisions.	Volts.	Divisions.	Volts.	Ohms.
h. m.					
0 0	360	1.80			
0 1	360	1.80			
0 2	. .	....	440	1.47	
0 3	370	1.85	422	1.41	.223
0 4	370	1.85	423	1.41	.223
0 7	371	1.86	423	1.41	.228
0 10	377	1.88	423	1.41	.238
0 14	376	1.88	419	1.40	.245
0 17	380	1.90	424	1.41	.248
0 21	380	1.90	424	1.41	.248
0 24	379	1.89	426	1.42	.246
0 27	379	1.89	424	1.41	.248
0 32	378	1.89	423	1.41	.243
0 37	378	1.89	424	1.41	.243
0 41	376	1.88	423	1.41	.238
0 45	376	1.88	422	1.41	.238
2 5	368	1.84	407	1.36	.252
0 35	366	1.83	398	1.33	.261
3 5	365	1.82	397	1.32	.270
0 45	362	1.81	388	1.29	.288
4 45	360	1.80	369	1.23	.331
5 15	358	1.79	348	1.16	.388
21 30	280	1.40	124	.41	1.72
45 0	23	.11	4	.013	5.23

Orne Cell.

Time.	E		E′		R
	Divisions.	Volts.	Divisions.	Volts.	Ohms.
m.					
0	357	2.00	450	.985	.74
1	325	1.82	320	.700	1.14
2	316	1.77	287	.628	1.30
3	314	1.76	259	.567	1.51
4	309	1.73	215	.471	1.91
5	307	1.72	209	.458	1.98
6	315	1.76	155	.339	3.00
7	316	1.77	146	.320	3.23
8	317	1.77	128	.280	3.80
9	317	1.77	113	.247	4.41
10	318	1.78	102	.223	4.94
11	320	1.79	101	.211	5.35
18	320	1.79	81	.177	6.51
24	314	1.76	66	.146	7.90
35	312	1.75	59	.129	8.98
43	315	1.76	54	·118	9.94
52	315	1.76	47	.103	11.49
Clarke	360		665		

The above are specimen observations. In general I may say that every cell has its own peculiarities, from the shape of whose curves for E. M. F. and R the cell may usually be recognized. Thus, the curves of the ordinary bichromate cell show at first a rapid, then a gradual falling off, of E. M. F.; and at first a marked decrease, then a gradual increase, in R. The Leclanché cell resembles the bichromate as far as E. M. F. is concerned, but R in this cell remains nearly constant.

Physical Laboratory of Tuft's College, June, 1885.

THEORY OF MODERN ELECTRIC MACHINES.

BY J. ASHER.

The action of electro-motors and dynamos can be explained by known laws of electric currents. Law 1. Parallel currents which flow in the same direction attract each other. Law 2. Parallel currents which flow in opposite directions repel. Law 3. Two currents which *both* tend either towards or from the same angle attract. Law 4. If one current tends *towards* and another *from* the same angle they repel.

An illustration of law 4 is found in Gore's experiment, which is described in Cazin's work on heat. Two small copper rails are placed parallel and a short distance apart, that a copper ball may roll on them. One terminal of a battery is connected with the right end of the first rail, and the other terminal to the right end of the second rail. The ball rolls from the ends to which the wires are joined. Cazin says the current heats each rail beneath the ball, causing an elevation, which determines the motion. My explanation is different. The motion is caused by the repulsion of electric currents, as in law 4. The current flowing from the battery along the rail tends *towards* the angle where the ball meets the rail; the current passing through the ball tends *from* the same angle. Again, the current flowing through the ball tends *towards* the point where the ball meets the second rail, then tends *from* the same point on its way along the rail towards the battery. A repulsion of the current flowing through the ball is caused by the current in each rail. A small wheeled carriage will roll along in the same way.

Barlow's wheel rotating between the ends of a magnet by the action of a current flowing from centre to circumference, or *vice versa*, has been thought the simplest rotary electro-motor. Now, it is not generally known that the wheel will rotate without the aid of a magnet if the current deviates in the plane of the diameter from the direction in which it flowed on meeting the circumference. This is another illustration of law 4. The ball on rails is the simplest electric locomotive. The rotating disc is the simplest stationary rotary electro-motor. We get little power from these, for we have but one *ply* of the current.

The action of a small Gramme machine used as a motor is explained as follows:—The armature is an iron ring wound in sections with insulated wire. The ring shields a current traversing the wire within from the action of the currents of the magnet. Were the ring of diamagnetic material the action exerted by the magnet on the current passing through the wire covering the exterior of the ring would be partially counteracted by its influence on the current flowing along the wire inside the ring. A permanent magnet may be considered a system of electric currents, according to Ampère's electro-dynamic theory. The resultant of these currents in a straight magnet surrounds it at the surface in the middle of its length. The resultant in a **U** magnet is between its limbs, and some distance from their ends. Figure 1 represents a small Gramme machine. The permanent **U** magnet is provided with curved iron pieces near the ends, which nearly enclose the armature.

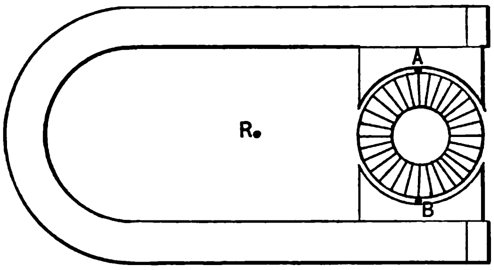

FIGURE 1.

These pieces cause the resultant to have a position nearer the ends. The resultant of the ampère currents in the magnet is at R, and is a straight current flowing from the reader if the upper limb is, as I suppose, a north seeker. The wire covering the exterior of the armature's upper half is traversed by a current entering at the commutator which is not shown. The wire covering the exterior of the lower half is simultaneously traversed by a current flowing in the opposite direction. Let the resultant current passing along the exterior of the upper half be supposed to act at one point, A, as a current indicated by the dot, and flowing towards the reader. Similarly let the resultant current flowing along the wire covering the exterior of the lower half be supposed to act at one point, B, as a current indicated by the dot at B, and flowing *from* the reader.

Now, since B and R are parallel and flow in the same direction, that is, from the reader, the current R attracts B. And because A and R are parallel and flow in opposite directions R repels A. Thus the armature has a tendency to rotate in the same direction as the hands of a watch. The commutator and sections of wire on the armature are so arranged that the resultants, A and B, remain nearly stationary in relation to the magnet. Each resultant of the armature is like a dog on an endless tread motor. The animal ever moves, but never advances. In the larger Gramme machines the axis of the armature is parallel to the axis of the magnets, of which there are two placed end to end. In a machine of this kind there are two curved resultants for each magnet. The action of these upon the current traversing the ring is a case of laws 3 and 4. The resultant of the current on each half of the armature is attracted by that part of a resultant of the magnet which tends either towards or from the same angle, but it is repelled by that part which tends in a different direction. These machines have electro-magnets instead of permanent magnets. The resultants are between the limbs of the magnet.

Siemens's machine has two electro-magnets, end to end. The armature rotates between curved iron extensions in

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the middle. The axis of the armature is at right angles to that of the magnet. The armature is an iron cylinder wound lengthwise. The right resultant of the double magnet attracts one resultant of the armature and repels the other. The left resultant of the magnet attracts the other resultant of the armature and repels the one. Is iron essential in the armatures of machines of the Siemens type, such as Weston's, Edison's and others? It would be interesting to try one of these machines with a wooden armature. It would not heat, and it would be *light*.

The Meritens motor has a magnet in the form of a wound ring which entirely surrounds the armature. The magnet has two resultants. The armature is a wound Pacinotti ring similar to the Gramme. The resultants of the magnet act upon those of the armature.

The Griscom motor has an annular electro-magnet like that of Meritens. Within this electro-magnet rotates an armature of the early Siemens type. It is an iron cylinder with a wide, deep groove on each side, in which wire is wound. The motor is shown in figure 2.

R is the annular electro-magnet wound on its right and left sides. A portion at the top and bottom is bare, as shown. The armature is shown within the ring. The iron ring shields the armature from the action of the current flowing along the wire on the outside of the ring. Could this wire act it would tend to rotate the armature in the opposite direction. The resultants of the electro-magnet are at A and B; those of the armature at C and D. Suppose A flows from and B towards the reader. Also suppose that C flows towards and D from him. A repels C and B repels D, because A and C are parallel and flow in opposite directions, and because B and D are parallel and flow in opposite directions. This repulsion continues until the armature has passed through about 90°, when A will attract D and B will attract C, because the current D flows in the same direction as A, and C flows in the same direction as B. This action continues until the armature has passed through 90° more; C is then as near to B as possible, and D is as near as possible to A. There is a dead point here, and another when it performs the next half-revolution. After starting, the momentum suffices to carry the armature over the dead point, the current being reversed in the armature, by means of the commutator, just as it approaches the dead centre. In the figure the armature rotates in the same direction as the hands of a watch.

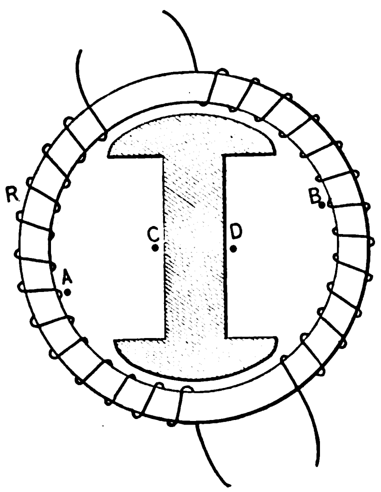

FIGURE 2.

The generation of electricity by machines such as those of Gramme and Siemens may be explained by the laws of induced currents in a conductor moving towards or receding from an electric current. Law 1. When a wire approaches another parallel to it through which a current flows, a current will traverse the moving wire in the opposite direction to that in the other. Law 2. When the moving wire departs from another parallel to it, through which a current is flowing, it will be traversed by a current which flows in the same direction as that in the other wire. Law 3. If a wire, A, conveying a current be caused to move in a certain direction by the action of another current traversing a wire, B, then on moving A in the same direction when it is not connected with a generator a current will traverse A in the opposite direction to that in which its former current flowed. Law 4. On moving A in the opposite direction a current will traverse it in the same direction as that of A's former current. Laws 3 and 4 include laws 1 and 2, but they also apply to cases of angular currents. Laws 3 and 4 explain the action of the larger Gramme machines when used as generators of electricity. In figure 1 let us suppose that the armature is rotated in the opposite direction to the hands of a watch; the wire forming the exterior of the upper half constantly approaches the resultant ampère current at R; hence the wire on that half of the armature will be traversed by a current opposite in direction to that of R. Also, since the wire on the lower half constantly recedes from the resultant R, it will be traversed by a current in the same direction as that of the resultant R. Now, the commutator arranges these currents so as to reinforce each other in the external circuit. In ordinary dynamos a large electro-magnet is used. The ampère currents in the electro-magnet cause the machine to generate a current in the armature wire immediately when set in motion; then a portion of this current passes through the wire on the magnet, and greatly increases the force of the resultant R. I speak of ampère currents in the magnet of a dynamo even when the machine is at rest, for there is always some residual magnetism in iron after having been rendered magnetic.

In explaining the action of these machines I have made no use of the terms "poles" and "lines of force." Ampère's beautiful electro-dynamic theory of magnetism should be constantly kept in the mind of the electrician. The same applies to his laws of the action of currents on each other. These, together with the fact that iron shields an electric current from another on the other side, have not only enabled me to explain the action of any dynamo or motor, but they have also been the means of my inventing several electro-motors and continuous current dynamos without commutators. This result only a few years ago was deemed utterly impossible. Ampère's electro-dynamic theory and laws of attraction and repulsion of electric currents leads me to believe that a continuous motive power can be obtained from permanent magnets. The law of conservation of energy would not be broken if this proposed machine be found to work. The molecular motion in the magnets would be diminished at the same time as motion of the mass occurred, the sum of energy in the universe remaining precisely the same. Those magnetic motors would be universally used in clocks and watches, no winding being required.

COLDSTREAM, Ont., Canada, July 6, 1885.

TECHNICAL JOURNALISM.

BY RALPH W. POPE.

TECHNICAL journalism is the natural outgrowth of industrial progress, and contributes largely to that development of science and invention which has been characteristic of the nineteenth century. While the more important discoveries are eagerly sought out and made public by the enterprise of the daily press, the quiet workers who by their skill and ingenuity patiently labor to bring their experiments into practical form, may have toiled for years in comparative obscurity.

Such men must necessarily keep thoroughly abreast of the times, at least so far as concerns their particular line of investigation, and to them the technical journal is indispensable. It must indeed be a stupid periodical which in the course of the year does not bring them information of far greater value than the price of subscription. Such knowledge is therefore a necessity, rather than a luxury. While we may derive a certain amount of satisfaction from perusing our favorite daily, it is the technical journal which brings to its supporters the bread and meat of every day life. Its field is constantly broadening while bright minds are continually on the look out for opportunities previously neglected. While the type founders and printers have long been represented, it was not until re-

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cently that the actual makers of a newspaper, the editors, reporters and contributors, were enabled to read a weekly devoted to their own interests. It is to such a journal that we must turn, to learn the methods of the craft, and it is there we find that the great editor is not always the just and unprejudiced man which his followers are led to believe. In its advice to writers seeking employment, the *Journalist* says: "Give particular attention "to the style of the paper and the hobby-horses of the "editor. Every paper has a weakness. The editor, for "instance, may own a lot of gas stocks. If you know this, "anything pitching into the electric light would be particularly desirable. . . . . Statistics are often good "things to furnish. They are hard to cut down, and "the editor rarely knows anything in regard to them."

The frequent inaccuracy in the minor details of ordinary newspaper work was recognized as long ago as Lord Byron's time, else he would not have replied as he did to the query—"what is fame? To be killed in battle and have one's name spelled wrong in the despatches."

Even in the limited experience of the writer, he once figured in the New York *Sun* with great particularity of street, number and business position, as the husband of his brother's wife, an error which was perpetrated with such exact accuracy of other details that its origin still remains a profound mystery. Such mistakes are the more readily excused because of the haste with which material must be collected and prepared. There is, however, another class which are more properly blunders arising from the ignorance of writers upon the subject they attempt to elucidate.

The reporter who described an accident at Jersey City in which a train plunged through the station and the locomotive went off the wharf, gave as the cause, the failure of the "backing" brake. Had he been more familiar with railway mechanism, he would have known that while a brake may be used to stop a train, the engine must be reversed to back it. What he doubtless overheard, was that the "vacuum" brake failed, as was really the case. It was another scribe, doubtless more familiar with atmospheric exhaustion, whose practical training secured him a position on the *Herald*. This genius examined an East river steamboat after an explosion, and discovered a vacuum in her cylinder *six feet long*, which had been broken into seven pieces! Scientific accuracy can scarcely be hoped for in such cases, but when we read in a description of a boiler explosion that "the path taken by the boiler was immediately followed by ourselves," we naturally infer that the reporter was blown up as well.

It may be too much to expect that these details can be carefully watched, as it is well known that but a small minority of newspaper readers will detect such errors, unless they are personally familiar with the subject or incident. It is when our metropolitan dailies venture outside of their province, that they should exercise more care in the preparation of their matter, or at least refrain from dictating the exact course to be pursued by others. It is a common saying in press circles that every man thinks he can run a newspaper. It is also apparent that every editor knows how to run other people's business as well as his own. In the palmy days of Napoleon III. the modest leader of the New York press at that time, would occasionally intimate that if Louis Napoleon would take the advice of the *Herald* many of the difficulties which beset him might be avoided. Whether his eventual downfall could be ascribed to his obstinacy in this respect, is a question for the historian who is more familiar than I am with the mysteries of French statesmanship.

It is frequently the case that under the guise of scientific phraseology a newspaper may cause at least annoyance, and perhaps injury by gross exaggeration or a misstatement of facts. A recent case which was particularly atrocious, was that of the *Evening Telegram*, in which an attempt was made to show that from an artistic and engineering point of view the Bartholdi Statue of Liberty is a failure. Imagine the assurance of a critic of this character, in pointing out to an educated engineer, such as we may presume General Stone to be, that the truss-work was not properly planned. Perhaps it was not, but why should it be left to a *Telegram* reporter to point out technical defects in a work of this character? He then undertakes to prove that in the joining of the iron framework to the copper plates of which the statue is formed, electrical action must subsequently ensue, which will ultimately destroy the metal at such points. With equal foresight many other dire evils could be predicted which *might* occur if proper precautions were not taken to prevent them. Fortunately the animus of this remarkable display of newspaper science was thoroughly understood by the public, and the proper allowance made for these extraordinary criticisms. Similar cases arise, however, in which the motive of the attack is more obscure, when the pernicious influence may consequently be more effectual.

The crusade of the press against the overhead wires is an example of the manner in which the people may be incensed against a minor evil, while more imminent dangers beset them on every hand, that remain comparatively unheeded. For years the law has recognized the necessity of regulating the construction of buildings, the testing of steam boilers, the inspection of steamboats, and the licensing of engineers and pilots.

We have had a cycle of falling buildings in this city and vicinity within a few weeks; a reckless builder has been sentenced to prison and quiet now reigns, the subject being considered stale. No anxiety is manifested in the daily press regarding the thousands of steam boilers "underground," many of them in charge of engineers (?), who are also expected to serve as porters, or men-of-all-work in their respective establishments. Among technical papers the *American Machinist* has frequently alluded to the various mechanical death-traps which pervade the community, a recent instance being its reference to the numerous excursion boats which daily ply our harbor in every direction; many of these steamers are crowded to their utmost carrying capacity, in open violation of the laws which are supposed to protect the people from the avaricious and unscrupulous owners who risk human life, that dollars may be gained. The masses, however, are neither scientific nor mechanical, or if they were they might not be influenced by the opinion of a technical journal, consequently its reasoning, however weighty, is of no avail, because it is misplaced. While those who read its columns may be interested for the time being, there appears to be no manner in which the evils pointed out may be eradicated. The necessary laws exist already, but they are apparently not enforced excepting perhaps for a brief period under the stimulus of some appalling disaster. In a few days any further reference to it is overwhelmed by the later intelligence of perhaps a more serious calamity.

One of the gravest drawbacks to the influence of a journal, is the question as to the honesty of its opinions; in fact, its reputation. It is here that the technical journal finds its path continually beset with thorns. The interests of its readers demand that they shall be enlightened on the merits of new inventions, processes and materials. They do not care to learn from John Smith that in his opinion the Smith dynamo will supply more Smith lamps per h.p. than the dynamo of Jones. Neither do they hanker after Jones's remarks on the Smith machinery. If, however, they have confidence in their favorite electrical journal, they might be glad to obtain, if they could, an official editorial decision.

It is right here that the sphere of the technical journal must be bounded. It should offer a fair arena for the statement and elucidation of facts and theories, by those who profess to understand them, under their own names, which, if well-known, carry with them the necessary weight; if not, the reader must judge from the article itself

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whether the author probably understands his subject.

It is often the case that the technical journal, acting solely in the interest of its readers and without reference to its advertising columns, publishes descriptive matter which is supposed to be beneficial to the inventor, manufacturer or vender of the article in question. It is too frequently understood that financial inducements are offered to secure what is erroneously considered an endorsement of the article, when, in fact, no opinion of its merits is advanced.

Having in view the fact that the mission of the technical journal is to instruct, inform and please its readers, the editor should certainly reserve the right to give a favorable opinion if he so desires, but not without careful investigation. His reputation is to a certain extent his capital, and should therefore be guarded with equal consideration. No allotment of stock or admission on the ground floor of a new enterprise should be allowed to bias his judgment, neither should he by his supposed influence lead others to embark in questionable enterprises.

We have in mind various schemes which have been boomed by different daily papers. Possibly in some cases such advocacy has been paid for, but if not, the desired result was attained by taking advantage of the technical ignorance of the staff, and thousands of readers were misinformed if not duped.

A recent instance is that of the Hathaway printing instrument for the introduction of which capitalists are now being invited to invest. It was announced through the medium of various newspapers that the introduction of this machine was to create a revolution in telegraphy, superseding not only the ordinary Morse instruments, but the telephone as well. The facts are that this machine is a very inferior printer, by no means equal to those in actual use 25 years ago. The only patentable features about it are of no practical value whatever.

At the very outset of the electric lighting business in this country a panic in gas stocks was precipitated by the wildest predictions regarding the future of the new light, which was to be produced at so low a cost as to ruin existing gas companies. There was no foundation for such assertions, but many people were led to sacrifice excellent securities without any better reason than that the newspapers prophesied the final overthrow of gas monopolies. This was seven years ago, and the smile of the present holder of gas stocks is broader than that of most electric light owners. Investors in Keely motor stock were not allured into their present holdings by the representations of technical journals. There has never been an exhibition of the Keely apparatus which really warranted an extended newspaper notice. The whole affair has been brought into notoriety by writers who were not sufficiently versed in science or mechanics to detect its fraudulent nature.

It certainly appears as if would-be investors in questionable enterprises of this character should endeavor to familiarize themselves with the "state of the art;" either by continued perusal of journals devoted to such subjects or else by the employment of trained experts, whose opinions are entitled to weight. A purchaser of real estate would be considered lacking in judgment, unless he engaged competent counsel to search the title. A similar prudent course should be adopted by those who propose to secure an interest in inventions which are not in their line of business.

In pursuance of my subject I have been led to digress somewhat in order to show not only the importance of technical journalism in its relation to the general public, but also to point out the shortcomings of the daily press in its treatment of special subjects.

That this state of affairs can be improved by careful editing is shown by the successful manner in which the respective hobbies of different editors are treated in their columns. No doubt the gradual development of the modern newspaper, whose field is the world, will eventually lead to the organization of a staff which will embrace not only base-ball and billiard experts, but trained scientists and mechanics. The mission of the technical journal will not then be ended however, but its opinions will be entitled to more respect, and its journey to the waste basket less rapid and impetuous.

TARDY ADOPTION OF RAILWAY IMPROVEMENTS.

Railway inventions secure adoption very slowly, though this is because of obvious reasons and is really very fortunate for every one but inventors. Looking back over the years, we remember that long after the Miller platform had proved itself invaluable, and was largely in use, one of our greatest trunk lines still coupled its cars with link and pin, and endeavored to render the transit of passengers from car to car less dangerous and unpleasant by keeping a short plank across the ever varying gulf between the swaying cars.

The air-brakes, too, were looked on by many of the older eastern roads as a new-fangled western device of doubtful utility, and, till appalling accidents compelled, few of the New England railroads had condescended to adopt them, and to-day those self-same roads find a hundred reasons why they should not adopt a uniform system of signals which has met the approval of a large majority of the railroads of the country.

Talk of insular prejudice! Why, ten years ago nearly all our railroad men scouted the idea of track signals other than a red flag or a ball hoisted on a pole. The complicated system used in England might do for John Bull, they said, but it would never be used here. To-day our principal railroads have not only adopted those very signals, but have even improved on the English block system. Now, we have signals at short distances apart which indicate to the engineer with unerring certainty whether the track is clear to the next signal ahead, and which he is otherwise forbidden to pass. These signals are worked by the power of electricity, called into action by the passage of the train itself and depending on no human agency Their automatic action is most interesting to watch. You may be standing near one, no train within sight or hearing. Presently you hear the distant rumble or see the puffs of steam that indicate the approach of a train. As it nears the signal, you see the red disc fall, or the vane of lattice bars revolve, in time for the engineer to note its action. He sees it change and knows at once not only that the track ahead is clear, but that till he has passed the next signal ahead, this faithful signal will forbid the passage of a following train. You wait and watch as the train disappears, and soon the red disc moves, or the lattice bars revolve back to their former position, and you know that the train has safely passed the signal ahead. But this is not all. If the continuity of the track be broken by a rail removed for repairs, or if some straying cow has laid down on the track for a contemplative chew, the signal gives warning of the obstruction, and to fill the measure of its fidelity, if itself inoperative, it displays the warning signal of danger. Yet another purpose is served by electric signals. At level crossings and at stations a gong is made to ring when a train approaches within a certain distance, and the continuous ringing says clearly and unmistakably, "train coming, clear the track."

But the most perfect of signals can only call attention to some fact, and so long as the element of human vigilance is required to note them, so long shall we remain liable to accidents arising from human infirmities.

The English system of connecting and interlocking switches and their signals, in such a manner that one man controls the action of many without moving from his box, and by which the setting of a switch for a certain movement of a train holds all others till that movement is completed, has already been adopted at some of our larger stations, and seems likely to be gradually adopted with the inevitable increase of traffic.—*Railway Review.*

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THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 256.)

A novel but valuable idea has recently been advanced by Mr. E. T. Gilliland in the suspension of aerial cables, and it is thought well to advert to the same here. It is to provide a clip with stirrups like that shown in the figure below, one of the stirrups being open to one side and the other to the reverse side, and having two sleeves (or hooks if preferred) for the accommodation of suspending or leading-in wires.

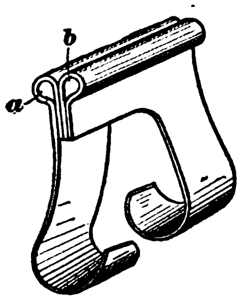

FIGURE 21.

It has been found in practice, particularly in certain districts, that the suspending wire becomes corroded so as to be unreliable, by the action thereon of the gas-laden atmosphere, and when such is the case the entire cable has had to be lowered, before a new suspending wire could be put in. By using the clip shown above and when the cable is first suspended, providing two wires from end to end, each passing through one of the clip sleeves *a* and *b*, such an inconvenience is avoided.

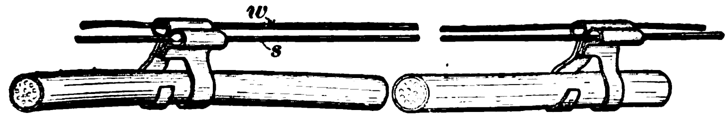

FIGURE 22.

Both of the wires *w* and *s* may be strong suspending wires, or one only may be a suspending wire and the other a light pulling-in-wire which may be of brass, phosphor-bronze or such non-oxidizable metal or alloy.

It is evident that by the use of this device whenever it is found that the supporting wire is corroded so as to be unreliable, a new one may be then attached to the other wire and drawn in; while a new drawing-in-wire can then similarly be attached to the corroded sustaining wire, so that when it is drawn out, it will draw after it a new drawing-in-wire, so that an alternative wire is at all times in place and ready for use. A little screw sleeve with tapered ends is used to connect the wires while drawing in, so that they will not stick while passing through the sleeves.

EARTH TERMINALS.

This, though frequently the last subject to be considered in building an electric line, can never be regarded as the least important. It is of course essential to the working of our circuit that it shall be completed in some way either by a return wire or by the earth. For long telegraph lines there need be no question as to which mode is the preferable one. Twice the length of line wire involving nearly a double cost for material, is a sufficient consideration, even if there were no other, to determine for us that such a line should be terminated at both ends in the earth. It is also a fact that long lines (if the earth connection is properly constructed) have a much smaller total resistance with an earth return, than they would have with a return wire, and hence are operated with a much greater degree of economy. If the earth connection is not well made, satisfactory working is absolutely impossible, and until rectified, the operation of the line will always be both difficult and expensive. Experience so far, has proved that although an earth return is the best for telegraph lines, it is not so for telephone lines; these to ensure good results, requiring complete metallic circuits in which both wires are parallel and as close as possible to one another.

Electric light circuits should always have a wire return, and, if possible, the out and in wires should pass by different routes.

Telegraph lines of less than half a mile in length, work better when completed metallically than when provided with earth terminals; while telephone lines work well on either, if the contacts are good, and the line is overhead.

For underground lines a loop circuit is preferable, as also where lines are to be frequently connected with double wire trunk lines.

In our large cities, good earth can always be obtained upon water or gas pipes; but a water pipe is always the best, and if accessible should be used. The reason for this preference is that pipe joints are usually made up and luted with red and white lead, which are really very fair insulators, and if a water pipe is used, the liquid itself aids to some extent in conducting the electricity. If both water and gas pipes are accessible, both should be used. If only gas pipes are accessible, the connection should invariably be outside of the meter, as otherwise the removal of the meter which frequently occurs, severs the connection with the earth entirely. If several series of water or gaspipes, or both, are at hand it is advisable to ensure the terminal by connecting the wire from the line with all of them. Wherever a pipe is used for this purpose, it should first be filed, and scraped quite clean and bright. For a short line a good earth may then be made by first winding a long stretch of copper wire of comparatively small size—No. 16 for example, very tightly, smoothly and regularly, round the pipe until some four inches of the said pipe longitudinally are covered with the copper. This can be tightened up by passing the last few convolutions through one another, and while the loose end is yet stretched tight, the whole should be well soldered over, leaving a loose end of about 18 inches long to splice and solder to the wire leading from the main line.

A long line terminal may be treated much in the same way, but instead of one small wire, several should be used, the ends of which may be finally twisted together before splicing to the main ground wire. This wire in long lines ought to be of large size, not less than No. 4 or 6, and before splicing it to the small wires it should itself be twisted eight or ten turns round the pipe. The splice of the small and large wire should then be laid over the convolutions on the pipe lengthways, and the whole again soldered.

Short line terminals, for instance those at the subscriber's end of an exchange telephone line, need not be nearly so heavy, but must certainly be soldered. It is sometimes good practice to employ clamps in such positions. These are adapted to grasp the pipe, and should be provided with a binding screw for attachment of the earth wire. In that case they make a reasonably good connection for a line which is not of great consequence, and have the advantage of being easily attached. They should also have a considerable amount of longitudinal surface and be furnished with a tight clamping screw, or one which has a set nut. If a large and long clamp cannot be obtained, a number of small ones may be substituted, and all ought to have a small movable plate of copper, brass or platinized metal, between the ends of the clamping screws and the pipe, so that not only, the screw ends but a good surface under them, can make the contact with the pipe. The weak point of clamps is their liability to the formation of rust between their inner surface and the pipe; and the tendency of their screws to work loose.

It is often difficult in country places and newly settled districts, to obtain a good connection, as pipes are scarce. In such cases we are compelled to resort to buried plates. Bars or strands of wire rope are by no means so effectual as earth plates. Earth plates ought always to be made of copper or of zinced or tinned iron.

These materials are recommended not on account of any degree of conductivity which they possess, but because by their use, the metallic surface is much longer kept intact,

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and oxidation retarded. The plates should never be smaller than three feet by four, and they ought to be about one-eighth of an inch thick. Ordinary or unprepared iron is not of much use as it rusts through very quickly. When it is necessary to resort to earth plates, to prepare them in a first class manner, we take two large insulated copper wires (No. 6 for instance) and attach them to the plate by the following mode:—Holes are made across the plate, in two lines, and the two wires are threaded through them—about four holes for each wire will do—the wires are then soldered to the plate at every hole. It should be needless to say that the portion of the wires to be threaded through the holes, must first be stripped of its covering. In setting the plate, the hole should be dug until damp earth is reached, and the plate must be set on edge, so deep that its upper edge does not come above the level of dampness.

All strain is taken from the wires, and above the surface of the ground they may be soldered together, and then spliced or jointed to a single iron or copper wire leading to the instruments and line. The idea of insulating the ground wire has been often ridiculed, yet after careful reflection I am inclined to believe that it is by no means such a subject for mirth as it has been thought. On the contrary, I believe that all points of a terminal earth wire, from the instruments to the ground line, or the pipe, as the case may be, should be well insulated, so that no electrolytic action can arise. When the earth wire is to serve as the terminal of many wires, it should be as large as can be conveniently handled.

Telephone exchanges of many wires can readily be operated without any main terminal earth wire, as each wire finds earth by way of all the others. Some offices are so worked. I have found in practice that it is scarcely an advisable arrangement, since it is quite conceivable that on many occasions, half of the lines may be in use simultaneously, in which case the joint resistance of the compound terminal is much diminished; I prefer therefore even in such cases, to provide an earth terminal of the highest character.

If it is suspected that the resistance of an earth terminal wire is too high, it should be measured, just the same as any other conductor. No earth wire and plate should measure more than ten ohms at the very outside.

Whenever earth plates are employed they should be of the same metal, as otherwise a permanent transfer of electricity takes place from one to the other through the line, for the two dissimilar metals being united by a conductor the necessary conditions for a current are present.

NOISE FROM MECHANICAL VIBRATIONS.

The noise caused by stretched wires when set in vibration is sometimes very loud, and very annoying.. This is one of the most serious objections to housetop lines, and also one which is most frequently urged by occupants of buildings to which the wires are attached. It is generally caused by the wind which exercises some influence on the wires even when its movement is not perceptible to the observer. It is peculiarly emphasized, when a great number of wires pass over and are attached to a building. The building itself, as might be expected acts as a sounding board, and if the wire is strained too tightly the vibration conducted down the frame of the building becomes an insufferable nuisance. Although, as noted above, it is usually to be attributed to the wind it is quite obvious, that such is not the only cause, since the vibration is sometimes at its height when the atmosphere is perfectly still. Every one has noticed the strong clear musical note which proceeds from a pole line, on still frosty mornings. The wires are then by reason of their contraction in response to the low temperature, like the strings of a musical instrument, and are in a condition to vibrate sympathetically with any mechanical vibration which may be occurring in their vicinity. Pole line vibration troubles nobody, and may be left unremedied unless it happens to be very loud indeed. With housetop lines the case is different, the noise must be either removed altogether, or materially tranquilized.

To accomplish this the wires must be *damped*, so as to remove their resonance. Various expedients may be adopted to accomplish this, the best way, however, is to insert a piece of strong chain in the line-wire, connecting the wire firmly to it at both ends, and also bridging the chain with a smaller wire attached to the line-wire at both ends of the chain, and soldered to maintain continuity.

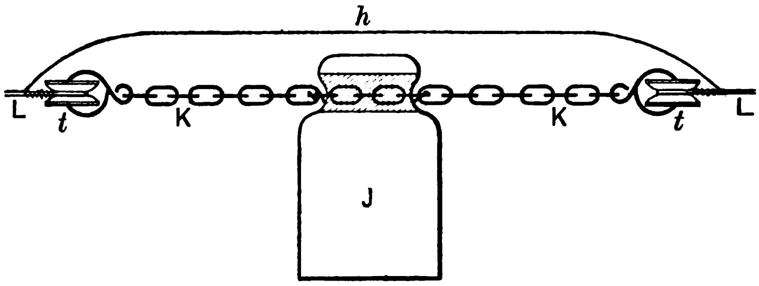

FIGURE 23.

Figure 23 shows how this may be done; the chain is bound to the insulator, which is first wrapped with soft sheet india rubber. In England the insulators are for this purpose sometimes wrapped with vulcanized rubber, or the wire itself is first, at the point of support, enclosed in a soft rubber tube and then wrapped with about a pound of lead wire. I have with telephone wire frequently adopted with success the following expedient:—Two pieces of stout india-rubber tubing like that employed to cover the rollers of an ordinary wringing machine, are cut about two inches long, and one is fastened at each end of a piece of line-wire four or five feet long by passing the wire through it, and twisting it back on itself. The piece of wire is then fastened by its middle to the insulator in the usual way by a tie wire. The main line is then cut, and its divided ends are fastened to the respective sections of hose by passing it round the outside; to preserve the continuity of the line, the small wire is fastened to the main wire, at a point beyond the two ends of the inserted piece, as described with respect to the chain remedy.

(*To be continued.*)

THE CENTRAL ELECTRIC LIGHTING STATION OF MILAN.[1]

BY G. COLOMBO.

WE propose to offer our readers, after 18 months of regular operation, a description of the Milan central station, together with its plant, its system of wires, the results hitherto achieved, and those that may be hoped for in the future.

The construction of this central station was decided on towards the latter end of 1882, by a committee selected to introduce the Edison system in Italy, who formed later the existing company, having a capital of $600,000, bearing the name of the *Società generale italiana di elettricità Sistema Edison*, with headquarters at Milan.

The company, having purchased a building situated in the street Santa Radegonda, formerly used as a theatre, began to demolish the theatre and to construct the new station in the month of October, 1882. The work was pushed so rapidly that the station with the first four machines was ready for work in June, 1883, the underground wires having been laid throughout the principal part of the territory to be covered, during the winter. Toward the end of June, 1883, the station began to work regularly every night until 1 o'clock A. M., with an average of 1,100 lamps. In August, 1883, the lighting of the famous *theatre de la Scala* was undertaken, two machines being

1. *La Lumière Electrique.*

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added to the existing four, for that purpose; and in November, 1883, continuous service, by day and night, was begun; until by the end of December, 1884, the number of lamps had reached 5,500, equivalent to 4,700 lamps of the normal standard of 16 c. p.

We will divide our description of the Milanese installation, for convenience sake, into the following sections:

1. The central station of Ste. Radegonde; 2. The system of conductors; 3. The principal installations; 4. The general working of the system.

I.

THE CENTRAL STATION OF STE. RADEGONDE.

This is a rectangular two-story and basement building of 147 x 42 feet, situated between the two parallel streets, *Agnello* and *Santa Radegonda.* The basement contains the machines, the next floor the boilers, and the top floor the store room and laboratory. This is a different arrangement to that usually adopted, which is to place the boilers in the basement, and was dictated by considerations of stability, in consequence of the great speed of the machines.

The machine room.—This occupies the whole ground floor, and contains at present six machines, with vacant spaces and foundations for four more, making a total of 10 for the station when it shall be worked to its fullest capacity.

The machines now in use are of the type known as the "Edison c," of which the following are the data:

Maximum current at 110 volts	900 ampères
Electromotive force, at the electrodes	110 to 120 volts
Resistance of armature	0.0039 ohms
Resistance of field magnets	2.28 ohms
Diameter of armature (8 ft. 2 in.)	2 m. 737
Length of armature (5 ft. 2 in.)	1 m. 630
Number of field magnets	12

Each of these machines has its own independent steam engine, of which the shaft is the prolongation of the axis of the armature. The normal speed of the armature, therefore, of the engine shaft is 350 revolutions per minute. Of the engines, two are of the Porter-Allen type, and the other four of the Armington-Sims pattern. Each of these machines can develop, at a maximum pressure of eight atmospheres, a maximum force of 130 to 150 h. p., corresponding to the demand, of 1,200 lamps of 16 c. p. per dynamo. A small separate steam engine actuates a ventilator for the aëration of the dynamo armatures, and a steam pump sends a current of cold water through the interior of the frames and foundations. These means of refrigeration are only needed when the machines are developing their maximum of work.

All the dynamos are coupled in quantity to two principal conductors of 1,700 square millimetres (2.6 sq. in.) section, and connected by means of the necessary switches and flexible copper conductors to the regulators and to the indoor test circuit, and to the two exterior feeding conductors, which enter the building at the opposite corners of this room. A current regulator is provided for each machine. Each regulator is formed of 50 bobbins, coupled so as to interpose in the field circuit of each dynamo a resistance varying from $\frac{1}{16}$ ohm to 7¼ ohms in all. The regulation is accomplished by hand, either for each dynamo singly, or for all at once, by means of a common shaft which rotates all of the contact arms. These are movable over the six discs of the regulators, each having 57 connectors representing 57 degrees of strength of current. Two indicators of electromotive force with electric bells, and two dial voltmeters are used by the persons who have charge of the regulation of the current. These instruments are regulated by a standard voltmeter, graduated by means of a standard Daniell cell and by a Thomson reflecting galvanometer. By this means the current is promptly regulated without alteration in the quantity of light furnished, even when the greatest alterations are made—such, for instance, as the sudden lighting or extinction of hundreds of lights at a time, for scenic effect in the *theatre de la Scala.* A local circuit, called the test circuit, is arranged so as to be traversed at the will of the attendant by the current from each of the dynamos. On this circuit are connected 1,000 lamps, or as many as should be operated by one machine at its maximum rate of work. These 1,000 lamps can be lit by groups of 50 at a time, by the aid of a switch. At the junction of the two principal conductors with the feeding conductors of the system are interposed feed-regulators, which will be explained later in our description of the system of conductors; their function is to equalize the electromotive force, and consequently the intensity of the light, at all points. In this room are also placed the ammeters used to indicate the quantity of current flowing through the system of conductors, and therefore the number of lamps lighted in the territory supplied by the station. These ammeters are simple needles, deflected by the current which passes through the principal conductors, placed beneath them, and can indicate up to 2,000 ampères with a trifling error; they are verified from time to time by standard lamps. Although it would be easy to furnish these ammeters with automatic registering devices, which may be done later, at present it is considered sufficient to read the indications once every quarter hour, as much for regulating the machines then working as for registering the course and amount of the daily work performed. Other apparatus, unnecessary to describe here, serves for diverse observations, such as the variations in the electromotive force at the ends of the feeding conductors of the system; indicators of leakage to earth on either pole of the system of conductors; measures of the corresponding electromotive force, etc.

Boiler room.—The boilers are installed in the first story, and at present are five in number, of which one is isolated and the other four connected in groups or batteries of two boilers each. They are of the Babcock & Wilcox manufacture, perfected in many details by Root. The choice of boilers was determined by the local conditions, which demanded boilers of a pattern at once light, small in comparison with the considerable force required, and inexplosive. Each boiler is composed of a group of inclined tubes, connected at the two extremities to horizontal reservoirs of steel plates, from whence the steam is drawn. The interior extremity of the tubes is in communication with a drum, from whence the smoke passes to the chimney. The principal data of each of these five boilers follow:

Number of tubes	96
Number of collecting reservoirs	2
Length of tubes	15 feet
Length of reservoirs	15 "
Surface of grate	12 sq. "
Heating surface, nearly	510 " "
Estimated h. p.	160
Total weight	42,944 lbs.
Surface occupied	60 sq. feet

Space has been left unoccupied for four more boilers, in case the wants of the service shall render them necessary. The boilers are fed by five Koertig injectors, two of which pump the water from the bottom of a well and empty it into reservoirs situated on the lower floor. There are also two direct-action steam pumps, of which one is ordinarily used for the refrigeration of the machines; but the piping is so arranged that either of these pumps, or both together, may be used for feeding the boilers. The steam pipes are so arranged that either machine can be detached from the others in case of accident, or for repairs.

The smoke from the boiler furnaces is carried to a chimney of 6 feet constant interior diameter, and is 156 feet in height from the street pavement.

Other apparatus is used for the hoisting and distribution of the coal. The coal burned is the best Cardiff, which produces very little smoke when the furnaces are

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charged, and practically none during combustion. No smoke-consuming devices are used.

Organization of the central office staff.—The direction of the service is confided to an electrician-in-chief, who has under his immediate orders: One or two engineers, according to the season, charged with the oversight of the work; one chief mechanician; one foreman electrician; one foreman mechanician; one foreman of firemen; and the working electricians (for the commutators), steam engineers and firemen. The staff is divided into gangs for day and night service.

During the summer season the number of lamps used in the district during the late hours of the night and during the day is only from 100 to 200; during the winter this number increases, and there are some days on which the lamps are in use by hundreds from daybreak, and in some places of public resort remain in use all night. During the hours when the lamps in use are only some hundreds, a small 400-light dynamo is used. As soon as the ammeters indicate that the number of lamps in use approaches 400, one of the large dynamos is started and the small one stopped. A second C dynamo is added when more than 900 lamps are indicated; for although the C dynamos will feed 1,000 lamps, and even more (with the maximum electromotive force of 116 volts), it is preferred not to charge them in actual service with more than 900 or 950. The same proceeding is repeated in proportion as the number of lamps used in the district increases, until the full capacity of four dynamos is reached, and this has not been exceeded up to the present time. The remaining two machines are kept in reserve, one of them being run at a reduced speed on open circuit, ready for use in a few moments if the occasion arises. Experience has shown that the introduction of a new dynamo, or the substitution of one for another, can be made in a few seconds, and in such a manner that an accident to a machine, such as the breaking or the heating of a part, has no injurious effect on the regularity of the service.

The increase in the number of lamps takes place very rapidly from twilight to 7 or 8 o'clock in the evening. The process above described is reversed in removing dynamos one after another from the circuit, when at a later hour the number of lamps begin to decrease. Ordinarily, one hour after the closing of the theatres the small dynamo is put in use.

The normal electromotive force of the station is shown by the indicators previously mentioned, whilst that at the end of the feeding conductors is regulated by means of the feed-regulators according to the indications of the ammeters. Thus the director of the station has completely under his hand the working of the lighting at all points of the system.

All of the statistics relating to the work of the station, as well as the number of lamp-hours, the consumption of coal and oil, etc., are registered daily and tabulated monthly for the information of the engineer-in-chief and for the administration.

II.

SYSTEM OF CONDUCTORS.

The central station of Ste. Radegonde, which at present is eccentrically situated in respect to the district served by its conductors, will on account of recent developments of the system of conductors, soon be in a central position, with radii of 1,500 to 1,600 feet in all directions.

The conductors are divided into two classes, called respectively *conducteurs d'alimentation* (feeders), and *conducteurs distribution* (mains), the distinctive uses of each being explained hereafter. Each line comprises two conductors, one going and the other returning, that is to say, each line is a tube containing two copper conducting bars separated by an insulating composition, according to the well-known Edison system, which has been previously described in these columns (see page 95).

The organization and manner of calculating the details of such a system are quite different from those required for any other conduits, as for water, air or gas. In such cases we start with a certain initial pressure (in the reservoirs, or in the gasometer), and the conduit is so designed as to lose a certain determined fraction of the initial pressure at the most distant points of the system. We have then at different points of the system at pressure, which is less and less in proportion as the distance from the origin of the conduit. The maximum loss of pressure may represent a considerable fraction of the initial pressure, since we can always proportion the delivery of the water, or gas, by appropriate orifices, whatever may be the pressure, or rate of flow, and thus compensate for diminished pressure.

For an electric lighting conduit, the problem is entirely different. Admitting as a general principle, that it is desirable to employ for the service throughout the whole of a system lamps of one standard form, which is equivalent to demanding the same electromotive force to develop their normal luminous intensity, it is evident that the permissible falls of potential between the two conductors, at any two points of the system must not vary much between themselves, without having lamps which would give a luminous intensity varying too much according to their positions relatively to the source of current.

Then, recalling the fact that for the standard Edison 16 c.p. lamp, a difference of one volt in the electromotive force, is equivalent, at the limits of the luminous intensity, to nearly one candle, one can easily comprehend that the greatest available difference in electromotive force at any two points of the system cannot without inconvenience exceed one and a half or two per cent. It is then necessary to design the system so that this condition may always be fulfilled; and this consideration forcibly excludes the application of the system in use for the distribution of water or gas. Strictly speaking, one could make up for a great variation in the available electromotive force by using lamps giving the same luminous intensity with different electromotive forces (that is to say, having different resistances), but that would entail complications in the service, which are entirely inadmissible.

To satisfy the condition stated it is necessary to divide the system of conductors into two parts: first, a system of conductors called mains, forming a circuit entirely closed and isolated from the central station; and second, a system of conductors called feeders, which, starting from the central station, carry the current to conveniently chosen points on the mains. This might be compared to a distribution of water by a system of intercommunicating canals, into which the water would be carried by feeding trenches proceeding from the source of supply, so as to establish an equal level at all points of the system.

The conductors forming the closed system of mains are those which run along the streets and serve directly for the distribution of the current to the houses of consumers.

They are inter-connected by joint-boxes containing fusible lead safety-plugs, calculated so as to interrupt the circuit whenever from any cause the delivery becomes abnormal and threatens to heat the conductors above the fixed limit.

The feeding conductors all start from the central station, and are all connected with the mains in joint-boxes of the same sort as those used for the mains. These joint-boxes have openings flush with the pavement, for the purpose of examining the joints and of making galvanometer tests.

The designing of a system of this sort can all be done with a battery and galvanometer, in the laboratory. An artificial system, on a reduced scale, is constructed to represent the actual system; the current is passed from the battery by feeding conductors branching to different points and always of the same resistance; then by experiment it is determined which are the most convenient points at which

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to make the junctions between the feeders and the mains, so that the difference of potential between any two points on the mains shall not exceed the fixed limit. Only, as it is impossible that a system thus planned shall not be subjected to subsequent changes by reason of the addition of new consumers, it becomes necessary to also arrange for the growth of the mains; this requires a somewhat laborious calculation to determine whether one or more feeders shall be supplied, or whether the points of junction between the feeders and the mains shall be displaced.

It was in this fashion that the existing system, planned first in the laboratory for about 3,000 lamps and extending only to *la Scala* theatre, about 1,380 ft. from the central station, has since been enlarged by the addition of two feeders, the displacement of several junction boxes, and the lengthening of all of the mains, so as to suffice for the 5,500 lamps now served, with the possibility of serving 7,000 without any further alteration, at a maximum distance, by the conductors of 1,890 feet, and 1,440 feet in a straight line.

The mains generally run on both sides of each street in the district served by this station, and are buried at a depth varying from 20 to 30 inches beneath the pavement. The tubes containing the mains are of No. 4 size, having two bars of copper of 930 square millimetres (1.44 sq. in.) each and 6 metres (19½ feet) long. The joints are made on the well-known system, by arcs of copper in cast-iron boxes, filled with the insulating composition. Twelve joint-boxes are used for the mains.

The loops to the houses of consumers are made by boxes of a special shape, from which the conductors are carried either in smaller tubes (Nos. 5, 6 or 7), or by lead-covered cables, and are then subdivided into distributing wires leading to the different places to be lighted.

The feeders are placed at the same depth, branching to the selected points on the mains by the shortest route and connected to the mains by six-joint boxes similar to those used on the mains. The feeders are large tubes of Nos. 1½ and 2 size, containing bars of 589 and 443 square millimetres (0.91 to 0.68 sq. in.) section. The shortest is 118 metres (383 feet) long, and the longest 504 metres (1,638 feet). Their resistance is from 0.0101 to 0.0393 ohm. The insulation resistance of all of the underground conductors connected together is 192,000 ohms.

The maximum loss for which the conductors have been calculated is 12 volts, when all of the lamps served by the station are in use. Adding the loss in the installations in the consumers' premises, calculated to be from 2 to 2½ volts for all of the installations, there is a maximum loss of electromotive force between the dynamos and the lamps of 14 to 14½ volts.

With the great variations in the consumption of the current caused by the addition of new consumers, the opening and closing of theatres, etc., it would not be possible to preserve a constant electromotive force, even within the limits indicated, at different points of the system, without the use of the feed-regulators at the ends of the feeders in the central station. By the aid of these the greatest variation in the available electromotive force at any two points of the system never exceeds 2 volts, or less than two per cent. of the standard electromotive force, adopted from the start which is 102 volts. Thus all consumers of Milan are served by lamps of 101 to 103 volts, limits which are never passed.

The theatre of *la Scala* being the most important consumer of the system has been the object of special precautions in designing the arrangements.

Notwithstanding the doubts expressed by many electricians, including Mr. Edison himself, the theatre has been connected directly with the system, although it uses an equivalent of 2,580 16 c.p. lamps and that exhibitions take place there only during the first three or four months of the year. It has been arranged so that it can be operated by an isolated plant if necessary, but up to the present time it remains connected with the general system.

We give below some data as to the extent of the system.

	Feet.
Length of tubes for feeders and mains	23,075
Average distance from the centre of gravity of the lighting from the station, measured on the conductors	1,430
Distance from the station to the centre of the principal group of lamps (around the theatre of La Scala) measured on the conductors	1,625
Distance from the station to the most distant lamp (Banca generale) measured on the conductors	2,047
Distance from the station to the most distant lamp in a straight line (Hotel Continental and Cercle des Artists) or maximum radius	1,560

III.

THE PRINCIPAL INSTALLATIONS OF THE SYSTEM.

On January 1st, the system comprised 5,530 lamps, equivalent to 4,745 of the standard 16 c.p. lamps, thus distributed.

	Lamps.
Theatre de la Scala	2,890
Theatre Manzoni	391
Hotel Continental	476
Cercles (clubs)	335
Cafés and Restaurants	725
Banks	103
Stores and dwellings	610
Total	5,530

Of these the most important is that of *la Scala* theatre. This is the largest opera house in the world, so far as the dimensions of the stage and auditorium are concerned, although the space allotted to the necessary portions not used by the public are somewhat restricted, owing to lack of ground. The stage is 147 feet deep by 121 feet wide. The auditorium is 81 by 71 feet, and 65 feet in height. There are 194 boxes, distributed in five galleries, not counting the upper gallery. The theatre was first opened on August 3d, 1778.

The municipal authorities insisted that the whole theatre should be lighted by electricity, to the entire exclusion of gas, at a time when the central station had just begun operations, allowing only five months in which to complete the installation. Happily, the installation of the Theatre Manzoni, just then completed, furnished an opportunity for the study of the apparatus for stage lighting which was to be used on a tenfold greater scale at *la Scala*. Yet much special apparatus for the purpose had to be invented to fill the peculiar demands of a stage so vast and where so much luxury is displayed in the mounting of the operas. The gas was entirely displaced and the theatre wholly lighted by incandescent electric lamps in time for the season 1883–84. The following are some of the details of this important installation: The total number of lamps in the theatre and its annexes is 2,890, of 32, 16, 10 and 8 c. p., respectively, equivalent to 2,580 of the normal 16 c. p. standard lamps. The current is furnished to the theatre as to all other consumers, night and day, and during one season the consumption has amounted in round numbers to 900,000 lamp-hours. Not a single accident to, or interruption in the service, has occurred since its inauguration in November, 1883, up to the present time. A second and much smaller installation is that of the Theatre Manzoni —391 lamps—from whence gas is also excluded.

Another installation, that of the Grand Hotel Continental, is, we believe, unique. This hotel is entirely lighted by incandescence, to the absolute exclusion of gas, and even of candles, since every room is furnished with the electric light. Portable lamps with flexible conductors and circuit-closers similar to those used for electric bells, are used. There are 476 lamps here, 32 and 16 c. p. being used for the public halls and saloons, and 10 c. p. for the chambers.

Two or three other installations are now in course of

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construction, and are rapidly approaching completion. As the gas company in this city has an unexpired monopoly, it is impossible to hope for a much greater extension of the system to streets and squares other than those now covered, although the public much desire it. The electric light has, however, brought about a reduction of 40 per cent. in the price of gas within the district served.

IV.

THE GENERAL WORKING OF THE SYSTEM.

When this enterprise was undertaken, there was only one other like it in the world, at New York, and even there the Pearl street station had only just started to furnish light. It follows, therefore, that its operations were conducted slowly, and often tentatively. Nevertheless, it prospered so well that on December 31st last it had a number of consumers which represented an annual revenue of $40,000.

At the present moment, the capacity of the six machines now installed at Ste. Radegonde is nearly reached. As the principle has been adopted of always keeping one in reserve, even in the times of greatest consumption (the month of February), and calculating the capacity of the c machine at 1,000 16 c. p. lamps, the present equipment will only supply 5,000 of 16 candles, or their equivalent in 32, 16, 10 and 8 c. p. lamps. The station can contain, however, and has fixtures ready for, four more machines and all accessories, capable of supplying, omitting the reserve, 9,000 16 c. p. lamps, or about 11,000 of assorted sizes. This number will suffice for the probable extreme wants of the entire district.

The new machines can be added at a less proportionate cost than the six original ones, on account of the preparation already made to receive them. The cost will be simply the purchase price of the machines and conductors, and cost of laying them. In regard to the conductors, any additions to the number of consumers will result in allowing a more favorable arrangement of the junctions between the feeders and the mains, so that the cost of these will be, per lamp, about 40 francs ($8.00), as against 56 francs ($12.00) for the original outlay per lamp. It may therefore be concluded that the first year of working the Ste. Radegonde station does not represent exactly the results that may be expected in 1885. So, if the first year of working has not only left the capital intact, but has produced a margin for renewal of the plant, it may be expected that the succeeding years will produce dividends. Not only will the diminution in the first cost of installation tend to this result, but also the greater economies which will be realized in the maintenance. In launching a new enterprise where it is imperative to succeed at any cost, notwithstanding obstacles, details receive little attention; but when the business is once well under way, the staff have leisure to economize in the working. One example suffices to prove this: The consumption of coal, which was at .50 kilos (1.1 lbs.) per 16 c. p. lamp per hour, has been reduced to .35 kilos (.77 lbs.) at present, with a prospect of a still greater economy in this particular. All of the other factors in the cost of working have been diminished in like proportion.

When the enterprise was started it was judged convenient to adopt a mixed tariff, depending on the nature of the consumption, viz.: a fixed tariff of so much per lamp per year for places like theatres, cafés, clubs, etc., where the average consumption per year varied little; and a tariff depending on the actual consumption, measured by the Edison metre, for private houses, stores, banks, offices, etc.

As to the tariff itself, the system adopted from the start was the most rational and the most convenient that could be adopted for an electric lighting enterprise, especially at its inception. Each lamp installed with a consumer represented a capital permanently invested for real estate, building, machinery and conductors. Even supposing that lamp to be used only one hour per year, the installation must provide for illuminating that lamp, since it might happen that all of the lamps in the system should be in use at the same time. This is especially true in Milan, because the lamps being chiefly in public places, it really happens that in winter, at a certain hour of the night, the greater portion of the lamps are in use. Each lamp installed ought, then, to pay the interest and the cost of renewal of its share of the capital invested, whether used during the whole year or not at all. This constitutes, in consequence, an *annual constant* that each lamp must pay, independent of its consumption.

Then there remains to be fixed the tariff of consumption, representing the cost of coal, labor, maintenance and spare materials. As this cost is nearly proportional to the time the lamp is used, this tariff is so much per hour per lamp, or rather, so much per hour and per ampère consumed by the lamp.

If the contract is by metre, the consumption is paid by the readings of the meter, which registers the quantity of current or the ampères consumed. If the contract is per lamp, the total hours per year are calculated; only, to check a consumption of light greater than that agreed on or foreseen, the consumer must pay, besides, for the renewal of the lamps. Up to the present time the latter form of contract prevails; but for stores and dwellings the tariff by metre is preferred, and will be applied on a more extended scale hereafter.

The following is the tariff adopted from the commencement, and having proved convenient by experience, is maintained integrally at present; it is based on the normal lamp of 16 c. p.:

	Francs.	Dollars.
Annual constant for the 16 c. p. lamp..............	35.00	(7.)

Tariff of consumption:

Per ampère—hour..................................	0.0533	(.01)
Per lamp, normal—hour...........................	0.04	(.008)

For lamps of 100, 32, 10 and 8 c. p., the constant and tariff of consumption are varied proportionately to the quantity of current which they expend.

It is evident that this tariff favors the largest consumers; not those who have the largest number of lamps, but those whose lamps are used during the greatest number of hours. Thus, for example, a consumer whose lamps burn during 3,500 hours per year (as in the case of street lighting), would pay annually for a normal lamp of 16 c. p. (equivalent to at least 180 litres of gas), a sum of 175 francs ($35), which amounts, per hour, to:

	Centimes.	Cents.
16 c. p. electric lamp..............................	5.0	1
Corresponding price per cubic metre of gas......	27.8	5.5

Which demonstrates the possibility and even the convenience of applying the electric light to public lighting.

Cafés, restaurants, clubs, etc., have an average consumption of 2,700 to 2,800 hours, which amounts to a tariff per hour of:

	Centimes.	Cents.
16 c. p. electric lamp..............................	5.25	1.5
Corresponding price per cubic metre of gas.......	29.2	5.8

Stores closing at from 9:30 to 10 o'clock P. M., and having an average consumption of 1,400 hours, would pay per hour:

	Centimes.	Cents.
16 c. p. electric lamp..............................	6.5	1.3
Corresponding price per cubic metre of gas.......	36.1	7.2

The price of gas is that of the monopoly accorded to the gas company of Milan, without counting 2 centimes ($.004) municipal tax.

Lastly, for dwellings and offices closed in the evening, counting the cost of the light on a basis of 700 hours per year, the tariff per hour would be:

	Centimes.	Cents.
16 c. p. electric light..............................	9.0	1.8
Corresponding price per cubic metre of gas.......	50.0	10.0

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The electric light is in this case dearer than gas, even at the price assured by monopoly, except in small towns, where gas costs, in Italy, 45 centimes (9c.), and even 50 centimes (10c.) per cubic metre. This is also the case with theatres having a small number of representations per year. In Italy, for example, all the large opera houses have a season of 40 to 60 representations.

These figures will suffice to give an idea of the conditions in which an incandescent electric lighting enterprise can be established and compete with gas. They certainly do not represent the last word that can be said of electric lighting. In the future we are sure that reductions will be made which will still further extend this grand application of electricity, which is still in its infancy, since there are but two instances of its exploitation on a large and important scale, viz., in New York and Milan.

As the cost of canalization increases rapidly as the distance between the central station and the furthest outlying lamp increases, it is most economical to establish stations in thickly settled districts, so that this distance shall not much exceed 300 metres (975 feet). If this light is to be adopted generally, to the exclusion of gas, a cheaper system of canalization must be devised. There is more than one way in which a practical solution of this problem may be sought; and although this solution may be reserved for the future, there is already one point gained in a fact whose importance surpasses that of all other accessory questions. This fact is the complete and practical success of public lighting by the incandescent lamp, together with the admirable system of distribution devised by Mr. Edison; a success which is hereafter assured by an experience of more than two years in New York, and of nearly two years in Milan.

SANITARY SUPERIORITY OF THE ELECTRIC LIGHT[1]

BY P. H. VAN DER WEYDE, M. D.,

President of the N. Y. Electrical Society.

The paper which I will read to you to-night, was prepared two years ago, in response to an invitation to furnish an article upon a sanitary subject for a journal devoted to that branch of science. This request arose from the publication of my report upon the defective sanitary condition of the court-house in Brooklyn which appeared in the *Eagle* of that city. Illumination by electricity being then one of the most important subjects attracting public attention, I decided to take it as my theme for the desired article, but upon its presentation I was informed that as it was a strong plea in favor of electric illumination, it could not be made use of for the journal in question, which was devoted to the interests of gas and gas-fitters.

I laid the article aside, but as the subject has received but little attention, I concluded to give it further publicity through a paper devoted to electricity, and to bring it, with some additions, before the New York Electrical Society.

Apart from the theoretical consideration which I will refer to further on, I will first call attention to the result of experience in the use of illuminating gas in libraries. It has been found that in the course of a few years, the books, and more especially the leather bindings become ruined, when the products of gas combustion daily pervade the air of the rooms. For this reason the trustees of the Astor library decided to dispense with artificial illumination, and open the rooms only during the day. The same rule has been adopted by other libraries, which, like the Astor, are especially devoted to the accumulation of books so rare and expensive, that comparatively few individuals can afford to purchase them, and which would therefore be inaccessible to those for whom they are the most useful, namely, the workers in science, art, and literature, who too frequently have neither time, opportunity, nor disposition to acquire wealth.

There is a very meritorious corporation in New York, the Historical Society, the rooms of which are often open during the evening, and its library, museum and picture gallery profusely illuminated with gas. Besides the injustice done to the artists by the yellow gas illumination of their paintings, and the gradually increasing injury done to them as well as the books in the library, I feel impelled to direct special attention to the famous Egyptian antiquities in possession of the society. They must suffer injury and will no doubt eventually be ruined. Forty years in our moist and variable climate, and placed in rooms frequently illuminated with gas will be more detrimental than the 40 centuries they were entombed in the pyramids, in the dry climate of Egypt. The rolls of papyrus covered with hieroglyphics, which have not yet been translated, will surely go to ruin, and before it is too late, they should be reproduced by a photographic process. This may be done on the spot by the electric light, without difficulty. Copies of such a publication sent to prominent antiquarians and the cognate institutions of Europe, would surely contribute largely to our knowledge of that ancient cradle of civilization from which Moses, that great reformer of the Semitic race, obtained his knowledge, and let us not forget that our modern civilization and religion is nothing but a continuation of the Jewish civilization originally derived from Egypt.

A few years ago I proposed to that society the publication of photo-engraved copies of these manuscripts, and if it is not done soon, I hope that the society will at least soon become convinced of the necessity of substituting the electric light for gas in the building, in order to arrest further decay of antiquities which cannot be replaced.

The theoretical considerations relating to the difference between electric and other systems of illumination, from a sanitary point of view consist chiefly in the fact that electric illumination does not involve the combustion of any material, consequently it does not deprive the atmosphere of its oxygen, while other methods involve the feeding of the flame by combustion and consequent absorption of atmospheric oxygen, necessarily resulting in the production of various gases, the principal of which is carbonic acid, carbon being the main element of the substances used for feeding ordinary illuminating flames.

In electric illumination combustion is not the source of light; it is true that in the electric arc, there is a slight consumption of the carbon points, but this is so very small as to be of no practical account, while with the use of the incandescent light, enclosed in an air-tight glass globe, there is no consumption of material whatsoever, except, when by some accident to the glass globe, air acquires access, in which case the lamp commences to burn in reality, and its life is extinguished at once. For this reason I object to the common expression that the incandescent lamps are "burning," or that the "burners are lit," or that certain "lamps have burned for say 50 nights." I refer to any authority for the definition of the word "burn," Webster says, "to consume with fire, to reduce to ashes; surgically, to cauterize; chemically, to combine with oxygen," etc.

Ordinary combustion therefore robs the air of oxygen continually, and this is a most important objection against illumination of that character. It is well known that the life of man is sustained by the continual absorption of oxygen, chiefly by the lungs, but also by the whole skin. The amount thus absorbed is 16 pounds per day, which being diluted with four times its amount of nitrogen, involves the consumption of 80 pounds of pure air every 24 hours, or more than 3 pounds per hour. Considering the small weight of air (which for the same bulk is some 1,000 times lighter than the human body), this is a large quantity, being some 300 gallons of pure air per hour, or five gallons every minute, of which a little over three gallons is respired by the lungs, and the balance by the skin, which takes a

1. Read before the New York Electrical Society, June 10, 1885.

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very active part in the elimination of effete gases from the system. The estimate here given is based on carefully conducted experiments, and is a striking proof of the importance of living in a pure atmosphere. It explains why a change of residence, even if only from one house to another, may involve important consequences in regard to the health of the inmates.

If now the continual consumption of pure oxygen is so important to the maintenance of health and life, it is evident that anything which tends to diminish the amount of oxygen present in the air, and to deteriorate the atmosphere in which we live and breathe, should be avoided.

We must next consider that experiments have also proved that every candle flame consumes as much oxygen as a man, and a lamp or gas flame from two to three times as much, and that they discharge the products of their combustion into the atmosphere. These products are, as stated above, chiefly carbonic acid, the same as exhaled by man, while, when lamps are imperfectly burning, the very injurious carbonous oxide may be produced, and other obnoxious gases, as every one knows who has ever experienced the odor of badly managed kerosene lamps. Common gas is often not free from sulphur, or other objectionable ingredients, throwing sulphurous and other vapors into the atmosphere.

Considering all this, it is evident that our common methods of illumination, at the expense of the pure atmospheric oxygen, which we need for breathing purposes, is highly injudicious; and it is no wonder that when they have been applied in crowded localities, where inferior provisions are made for ventilation, injurious, if not fatal results have been experienced.

The electric light, on the contrary, is produced by an agency outside of the localities which it illuminates. It is the combustion of the coal which heats the boilers, the steam generated drives the engine, which moves the dynamo-electric machine, and this generates the electric current, which ultimately produces the light. Combustion is also here the source of the light, but it takes place in a furnace, *and the products of this combustion are not thrown into the locality to be illuminated, but at a great distance through a chimney into the free air, and the chain of different activities involved in the operation has for its final result the total separation of this combustion with its flame, heat and smoke, from the light-giving apparatus, while in the ordinary methods of lighting they are all united in the room to be lit.*

The electric light possesses two additional advantages; it does not heat the air of the locality it illuminates, and in its nature approximates sunlight, more nearly than any other source of illumination known, which two points are also of sanitary importance. Keeping the atmosphere cool in crowded localities, rather than adding to it by numerous flames, is surely beneficial, while when properly used and screened, the cool, pure and white electric light must necessarily be better for the eyes and for the whole system, than the yellow light produced by flames, while its beneficial effects in the growth of plants have been the subject of experiments, which promise favorable results when properly applied.

Its similarity to sun or daylight, which is decidedly the most beneficial of all illuminations, is also proved by the success of making photographic pictures at night, in London, Paris and New York, by means of electric light, which pictures are taken in as short a time as daylight pictures, while in regard to artistic effect of light and shadows they leave nothing to be desired if the illumination of the sitter is only properly managed.

This consideration of the great amount of heat produced in common gas flames, and its almost total absence in electric light, is also important from an economical standpoint. In the combustion of gas, more than 95 per cent. of the latent energy is transformed into heat, and less than five per cent. into luminous rays, while in the case of the electric light it is the reverse, more than 95 per cent. of the electric energy being transformed into light, and less than five per cent. into heat.

In the case of gas, the heat is diffused by air currents through the whole locality, if no extraordinary measures have been taken to remove the products of combustion through expressly constructed channels, while in the case of electric light the much smaller quantity of heat is confined to a single spot, where, by its concentration, the temperature is much higher than that of any flame, but the confinement in the limited space prevents the diffusion of the heat, while that of the intense light is radiated freely.

The readiness with which we adopt improvements, such as electrical illumination for practical purposes, and the customary tardiness in this regard in Europe is illustrated by the two famous tunnels, the attempted tunnel under the Hudson River, New York, and the St. Gothard tunnel in Switzerland. In the first, electric lights were used from the beginning, while in the St. Gothard tunnel oil lamps were used, and in such numbers, that, according to the reports of visitors, the smoke was suffocating, and the heat 106° Fah. This is not to be wondered at, when we are informed that the number of men employed was 2,400, most of whom had a lamp each, while the daily consumption of oil was 150 gallons. More than 200 men have been killed by accidents, a greater number have been injured, while a still greater number succumbed or were obliged to abandon the work, being compelled to do so by reason of the stifling heat and smoke-laden atmosphere. We consider it criminal neglect not to use electrical illumination for an engineering work of this kind.

In regard to the objection sometimes made, that the glare of the electric light is unpleasant to the eyes when looked upon, we may answer that the solar brightness may be objected to, upon equal grounds. But nobody desires to stare at the sun; experience teaches us not to do so, and such will also be the case with the electric light. Then this objection will disappear, in fact, it has already passed away.

No doubt many of you have read with pleasure, if not with pride, the acknowledgement by Mr. Preece, the head of the British telegraph system, of the superiority of the electric illumination of our cities and towns over those of England. In an article, republished in most of our electrical papers, he refers to the gloominess he experienced upon his return to the streets of London illuminated only with gas, compared with the brightness of the principal thoroughfares of New York, illuminated as they are with brilliant arc lamps. This acknowledgement from a gentleman of his reputation, gratified me, especially as a little while before I had a discussion upon this topic with a member of the British Association whom I met in Montreal, and who insisted that New York was not to be compared with London, that he had been unable to find incandescent lamps in New York, and that the arc lamps he had seen were miserable. He was a specimen of a prejudiced man, who had no desire to see anything praiseworthy among us.

THE TELEMETER AND ELECTRIC LIGHT.

The incandescent light has been applied to the internal illumination of the telemeter by a committee of the German army. The lamp is placed in a little lateral tube or recess normal to the main lunette of the telemeter, and between the eye and cross wires. The lamp is lighted by two bichromate of potash cells. The light of the lamp passes through a small hole in the wall of the lunette, and illuminates the cross wires. This illuminating of the wires is found to double the distance that the telemeter will measure, thus rendering it still more serviceable as a means of coast defense.

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PROTECTION AGAINST LIGHTNING.[1]

BY ALEX. MC ADIE.

In his *Experimental Researches*, paragraphs 1173 *et seq.*, Faraday describes the miniature house he had built to test the question of protection from electrical discharges. It was a hollow cube some 12 feet high, wound around completely on the outside with wire. "I went into the cube," he says, "and lived in it, but though I used lighted candles, electrometers, and all other tests of electrical states, I could not find the least influence upon them, or indication of anything particular, given by them, though all the time the outside of the cube was powerfully charged and large sparks and brushes were starting off, from every point of its outer surface." Faraday's experiment is further exemplified in all modern forms of electrometers. It is necessary, of course, to shield the essential parts of the instrument from external electrical influences, and to do this the enclosing walls are generally tinfoiled, making practically an outer metallic covering. From mathematical considerations, it follows that the potential within a hollow conducting globe is constant. Electrical action external to this globe can have no effect on bodies within it, because their potentials being the same there is no difference of potential, and, consequently, no work can be done. From these considerations it is evident that a metallic covering would afford to objects within, certain protection against lightning. Maxwell, who did for electricity mathematically what Faraday did for it experimentally, in 1876, suggested to the British Association the plan based on the experiment of Faraday's quoted above,—of protecting a building from the effects of lightning by surrounding it with a sort of cage of rods or stout wire. The suggestion has not yet been applied practically to any extent, but nevertheless it remains the only suggestion of any value made in connection with the question of protection against lightning during the past 50 years. The effective lightning protector of the future will certainly be one based on Maxwell's suggestion. The lightning-rod as it now exists is not, as is too frequently supposed, a modification of Faraday's external metallic shield. The theory of the lightning-rod's action is altogether different from that of a metallic covering. The lightning-rod's efficiency depends on the properties of points in dealing with electricity. If an electrified body is brought near a conductor, it induces on that conductor an opposite electrification and is more or less attracted to it. If we fix a point to the conductor it will, under certain conditions, give off the induced electricity to the air, which if it come in contact with the inducing body will neutralize a like amount of the opposite electricity. A thunder-cloud being an electrified body induces on the earth a charge of opposite nature and the lightning-rod affords means for a partial neutralization. As Prof. Tait puts it, "a lightning-rod serves, rather to prevent the occurrence than to ward off the effect of the lightning flash." Experience shows very plainly that lightning-rods are useless against ball discharges of lightning or, in fact, any intense disruptive discharge. The theory of the rod's action requires that this should be so. Ordinarily as the thunder-cloud approaches, a convective discharge or glow occurs at the point of the lightning conductor (always provided that this is in good conducting connection with the ground) an evidence of the escape of electricity of an opposite kind, and a consequent neutralizing of that of the cloud. This silent discharge of course tends to prevent the disruptive discharge in which the danger lies. Under certain conditions lightning-rods may be forced to carry a disruptive discharge, a use for which clearly they are not primarily designed, and in which failure to retain and lead off the current imperils bodies in the vicinity of the rod.

Prof. Le Conte has pointed out (*Nature*, Feb. 24, 1881) that the path of the discharge, whether disruptive or convective, depends upon five variable conditions :—

"1. *Distance* of the thunder-cloud from the point of the conductor.

2. Variable dielectric properties of the intervening air.

3. Size of the cloud.

4. The variable tension of its electrical charge especially under the neutralizing action of the pointed rod.

5. The *velocity* with which the thunder-cloud approaches the point of the conductor, this last consideration being very important and at the same time difficult to formulate."

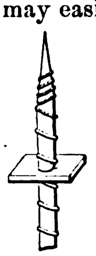
The rod may be inadequate to overcome the result of a sudden variation in one or more of these conditions, in which case a disruptive discharge of a violence correspondingly to the degree of the variation must ensue. The question then is, whether the lightning conductor affords a more attractive path to this electricity of high tension than other objects in the immediate neighborhood. If the rod does, it is eminently a protector; if it does not, it is a source of danger.

The space protected by a lightning conductor, is not, as is often laid down in treatises on the matter, a circular space whose radius is twice the height of the rod. Such a rule has never been verified experimentally, nor is there any good theoretical reason why it should be so.

As to the actual construction of lightning-rods in this country, a brief inspection of all the patents issued in the United States during the past six years on lightning-rods may be both profitable and interesting. The number of patents awarded is surprisingly small.

	Rods.	Conductors.	Couplings.
In 1878 patents were awarded for....	1	1	1
" 1879 " " " "	3	1	3
" 1880 " " " "	1	0	2
" 1881 " " " "	2	0	0
" 1882 " " " "	0	0	5
" 1883 " " " "	4	5	2
" 1884 " " " "	0	1	0
In all....................	11	8	13

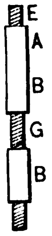
In addition to these there were patented : One machine for making lightning conductors at the place of erection, the inventor of which is a "down-easter"; four devices for protecting oil-tanks, all of which are common connections of the metal of the tank to the ground ; one lightning-rod ornament, one lightning-rod stand, and one tripod stand. The distinction between the rod and the conductor is that the rod is that part of the conductor which is pointed. Among these patents there is no one device especially ingenious or noteworthy. Good couplings are important, for a poor connection between sections of the conductor may easily render the whole worse than useless. The construction of a good coupling, however, is not difficult. Any good metallic binding that will hold fast and is not exposed to rust is sufficient. Several of the couplings patented seem well adapted for their purpose. Among these are couplings consisting of metallic boxes, hollowed out and secured to the sections of the rod by compression or screws. All forms of screw couplings are good, as is also the form consisting of a thimble in one section and a spring catch in the other, provided these connections are all non-corrosive.



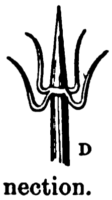
Among the lightning conductors may be noticed an independent, isolated, self-supporting lightning conductor, somewhat as figured in the diagram. Another form of conductor consists of a straight hollow zinc core, covered with sheet copper, and a series of twisted encircling tubes of zinc covered with sheet copper. It is to be noticed here that in the construction of lightning-rods no advantage can be taken of the fact that electricity resides on the surface. A hollow metallic tube is of little value as a lightning conductor. With one exception, the only other conductor worth noticing is a cable composed of twisted copper wires. This is an unobjectionable form of conductor, if

1. *American Meteorological Journal.*

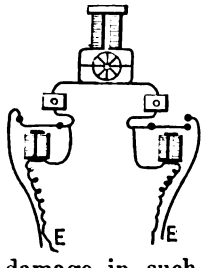
the diameter of the cable be a trifle greater than $\frac{1}{2}$ inch. A good form of conductor and rod is exemplified in one of the later patents, consisting of a flexible conductor, presumably a cable similar to the one previously described, lettered G in the accompanying diagram—in combination with the tube B applied to its upper end, the tip D applied at the upper end of the tube, and the rod A supporting such a tip. One patentee calls his invention by the proper name of the lightning-rod, viz: that of a lightning diffuser or neutralizer. It consists of an electrical conductor placed in a vertical position, and provided with one or more points at its upper and lower ends. These conductors are attached to different parts of the building and have no metallic connection with each other or with the ground.



This is in no sense a lightning-rod, and the writer knows not what its special mission may be. In another patent the gutters of the roof are connected with a ground terminal, consisting of a slitted tube, by an open trough. A hole in the latter permits the rain-water to fill the slitted tube, so moistening the earth at the ground connection. No mention is made of anything in the way of a conductor further than the leader, which is not serviceable. Further, it is obvious that, if the lightning precedes the rain, the design fails of its purpose. As a matter of fact the old saying that "rain follows thunder" is a very true one.



Most of the patents exhibit, if not ignorance, at least a lack of confidence in Ohm's law. Preece's experiments have proved that discharges of the highest attainable intensity conform to the law. As a consequence, no advantage is to be derived from either flat or tubular conductors, conductivity alone being concerned. Faraday long ago pointed out this fact, and in this very connection. Most of the designs patented are poor. There is no originality, little ingenuity and a marked absence of anything calculated to give the impression that the inventors of lightning-rods have any thorough knowledge of the theory and use of lightning-rods. If we turn for a moment to the methods adopted by telegraph companies, electric lighting companies, and other large corporations to whom the question of protection from lightning is a matter of financial importance, we find a better understanding of the matter, and a confidence in their methods and devices, born from experience and knowledge. Edison's device for protecting electric light systems from lightning consists of two conductors extending from each side of the external circuit to the earth. One is of high resistance and the other of low resistance. We insert in these two earth circuits an arrangement for controlling the low resistance circuit by the current in the high resistance circuit. A fusible wire is inserted in the high resistance, and an electro-magnet controlling a circuit-closer, acting upon cessation of the current. In case of lightning, the closing of the low resistance circuit affords a ready ground. The total damage in such a case is the fusing of a few inches of fine wire. The illustration is interesting, because it shows the perfect obedience of lightning to known laws of electricity, and at the same time the facility and safety with which, in intelligent hands, currents of the greatest intensity can be handled.



In erecting a lightning-rod, the question of a good ground inevitably comes up. One or two inches of loose surface soil is not a ground. Further, connection with leaders or gutters, in the great majority of cases, is not a ground. No matter how much the question of a good ground is agitated, the erection of rods, which are decidedly not well grounded, goes bravely on. One of the most curious, or rather startling, instances of this is that of the Sorbonne (the great building of the French university). Sometime in the summer of 1880 six lightning-rods were put up. In September of the same year the building was struck by lightning. It then came out that the ground connections were defective, making rather a suggestive comment on the actual worth of the knowledge of the scientists and government officials, under whose supervision the rods were erected. Professor Tait tells of a British light-house, recently examined, where it was found that "the lower end of the lightning-rod was *jumped* into the solid rock—a truly original form of earth." A well or spring, or flowing water, makes a good earth. A cistern or tank (non-metallic) is not an earth. A rule might be made to consider no earth good until tested. Lightning-rods should be tested. The inspection of these rods is an industry yet undeveloped in this country. There is an ample field for work, and it should prove remunerative. In France this duty is performed by the government.

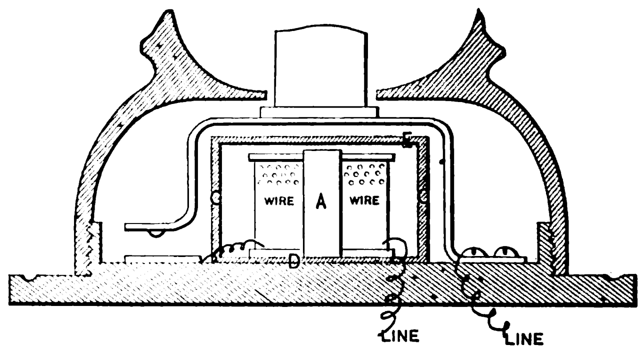
There is one final aspect of the question, not hitherto presented. The question of locality will determine to a great extent the use and nature of the rod. Places distant but a few miles from each other often differ greatly in the relative frequency of thunder-storms. In some localities the erection of rods is imperative, in others needless. Finally, the following further points should be regarded:

1. A solid galvanized iron rod should be $\frac{3}{4}$ inch in diameter, and a solid rod of copper at least $\frac{1}{2}$ inch. These are the best conductors.
2. No sharply bent corners or points should exist on the conductor proper.
3. The conductor should be as far distant as possible from metallic bodies not connected with the ground, or else connected with them.
4. The tops of the rod should be plated, or in some way protected from corrosion and rust.
5. Clusters of points, or groups of two or three, are advantageous.
6. Large trees in the vicinity, being efficient inductors, are of benefit, provided running water does not exist on the opposite side of the building.
7. Chain or linked conductors are of little use.
8. Painting will not interfere with the efficiency of the apparatus.
9. The conductors should not be insulated too well from the building.

CAMBRIDGE, Mass.

A USEFUL INVENTION.

A VERY simple little contrivance, called the Mackenzie Indicator, has been recently devised, which is intended to obviate one of the principal defects in electric bell systems. Under the ordinary arrangement, the person signaling with a push button is unable to determine whether the distant electric bell has responded. By this simple device,



however, the vibrations produced by the circuit breaker of the bell are audibly communicated to the person calling, provided everything is in working order. The principle of the indicator may be readily understood by an examination of the cut. In this case, as will be seen, it is placed inside of a push button suitably constructed, making a very neat

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and serviceable combination. The soft iron core, A, is fixed to the iron base, D, and is wound with a bobbin of wire, which forms part of the bell circuit. An iron box, C, is placed over this magnet, the lid, E, being close to the core. When the current passes through the wire, the core, A, and lid, E, being the respective poles of a continuous magnet, become magnetized with opposite polarities, and produce a sound which is repeated at every pulsation of the circuit breaker. This is due to the molecular action of the iron, no movable parts being used. The sound produced is sufficient to admit of its being substituted for a bell in quiet offices, where it is desirable to dispense with the annoyance of continuous ringing. It is suggested that it may also be very useful in connection with telephone exchanges, district telegraphs, and railway signals. It is being introduced by Woodhouse & Rawson, London.

THE WATERS RAILWAY SIGNAL.

The importance of electric signals in connection with railway service, has directed the attention of many inventors to the subject. Their aim is to secure that absolute reliability which is apparently impossible under human oversight. A system invented by William T. Waters, of Atlanta, Georgia, comprises some novel and ingenious features. The operation of his block system is very interesting, and is designed to cover every necessary point in connection with the movements of railway trains upon either a single or double track system.

It consists of a series of signaling stations which may be simply posts, with a metallic case containing the necessary mechanism to operate the semaphores. These stations divide the line into blocks, and each is provided with two distinct sets of signals. One set consists of semaphores for each direction, together with illuminated night signals for similar use; the second is a verifying-signal, visible both day and night, operated from either direction, and recognized as a signal whenever seen. The first set consists of four semaphore arms or discs, mounted on rods pivoted within the signal box. Each pair of these discs form an advance and a rear signal. The night signals consist of lights in fixed positions, changed by transparent screens in connection with the day signals. The verifying-signal is a revolving disc by day and a light by night, and the object of this portion of the system is to notify the engineer before leaving a given block, that his advance signal has or has not been displayed at the farther end of the block he is then to enter. The verifying signal is the main signal of the system. The signal mechanism is operated by a reversible electric motor provided at each post, which turns in either direction according to the circuit by which the transmitted impulse may arrive. The operation is entirely automatic, and is actuated by the movement of the train through the medium of a track circuit closer, or an insulated section of the rails, as may be deemed most expedient. The signal posts are connected with an ordinary single wire by means of which the various movements are controlled. The signals are interdependent. One train can in no manner interfere with the signals of another; neither can a train, without adequate warning, approach nearer than the distance of one block to a post whose indications are already controlled by a previous train. These results are attained by a combination of electro-mechanical devices which have been arranged with a view to eliminating all possible elements of danger, and at the same time providing a system which can be introduced at a reasonable expense.

STEEL FOR PERMANENT MAGNETS.

In the manufacture of telephones, magneto call-bells, and certain classes of printing and multiplex instruments, the power and permanency of the steel magnets is essential to excellence. It has generally been considered that the finest quality of steel was best adapted for this purpose. Curiously enough, however, a sample of steel which has been examined in the Patent Office at Washington, while possessing an extreme degree of hardness, appears to be almost wholly incapable of receiving magnetic polarity although subjected to various well-known tests.

A very severe mechanical test of steel is in its use for shoes and dies in quartz crushing mills. M. Furman Hunt, president of the Oxford Gold Mining Co., of Nova Scotia, in his annual report to the directors says:

"The adamantine shoes and dies, made by the Chrome Steel Works, Brooklyn, N. Y. have done admirable service, being replaced only after crushing 3,300 tons of quartz ore. From data of other gold mills at hand, this would seem to show a remarkable capacity for work, and not either on account of the softness of the ore, for on the other hand, the quartz is fairly hard and sharp."

The chrome steel is, however, well adapted for permanent magnets, and is already extensively used for that purpose. All manufacturers of machinery are naturally in favor of such material as secures the best results, and this is especially the case in making light electrical instruments, where the amount of raw material is comparatively small, while its quality is of great importance.

ABSTRACTS AND EXTRACTS.

ELECTRIC RAILWAY SIGNALS.

The Union Switch and Signal Co., of Pittsburg, has, notwithstanding the great depression that has prevailed in railroad business for a year, been in receipt of large orders for immediate delivery, the most of which are from roads which have within the past year or two adopted these appliances, while some are from roads which have heretofore opposed the interlocking system on account of its first cost. Recent accidents on some of the roads, and narrow escapes on others, have driven the managements to the introduction of their appliances.

The completion in 64 days of the contract for the pneumatic system, at Oakland Point, on the Central Pacific road, puts in operation the largest pneumatic interlocking and block-signaling system combined, in use in this country. The Central Pacific is now enabled to despatch trains in safety every half minute, whereas there were before almost daily accidents of more or less extent. This system at this point operates and controls 41 switches and locks, 1 draw-bolt lock on bridge, 110 signals, two highway-crossing bells, 32 bell circuits, 31 electric locking sections, 11 detectors and circuits protecting 13 switches, and is a striking instance of skill and ingenuity as applied to railway safety appliances. This same system is now in use on the Pennsylvania railroad between East Liberty and Wilkinsburg, a distance of about three miles, protecting the intervolved tracks where the traffic is heaviest, and where the speed of trains is greatest. The pneumatic interlocking system, without the block-signaling combined, is also in use at Fortieth street, Chicago, at the stock-yards; at Columbus, O., on the Columbus and Cincinnati Midland; at Brightwood, Ind., on the Indianapolis Union road; at Hammond, on the Michigan Central; at Valparaiso, at the crossing of the Fort Wayne and the Chicago and Grand Trunk; at Bound Brook, at the crossing of the Lehigh Valley and the Philadelphia and Reading; and at Erie, on the Lake Shore and the Michigan Southern.

The pneumatic block signal, without the interlocking, is in use on the Fitchburg road, between South Ashburnham and Fitchburg, and on the New York, Ontario and Western, between Cornwall and Caldwells, 42 blocks, covering 32 miles of track.

During the past three years the Union Switch and Signal Co. has erected, on all the important lines of the

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country, and on some of lesser importance, over 2,500 levers of Saxby & Farmer interlocking machines. The company expects during the present year to turn out about half of this number, basing calculations on the present rate of orders.

The increasing interest taken in railway safety appliances by railroad managers, railroad commissioners and legislators, as well as the demand of the public at large for better protection of trains at grade crossings, and the large damages generally allowed by juries to parties injured in cases where the adoption of well-known appliances would have prevented the accident, all tend to the speedy introduction of the various kinds of safety appliances, both for equipment as well as for the track.—*Railroad Gazette.*

AN ELECTRICAL PIONEER.

In a biographical sketch recently published in the *Sunday Call*, of Newark, N. J., the following reference is made to the electrical investigations of the late Seth Boyden.

"Soon after Daguerre, in France, succeeded in producing wonderful likenesses upon metallic plates, Seth Boyden studied out the problem, unaided, 3,000 miles away from the inventor, and succeeded in producing the first daguerreotype ever made in this country.

"From this he drifted into the boundless field of electricity, and although at this time a tyro as an electrician he boldly grappled with the lightning, and aided by his intercourse with Prof. Morse, who frequently consulted him upon the mechanical difficulties constantly arising in the way of the success of the wonderful telegraph, he soon became familiar with the subject. Of abstract science he knew but little; he was practical and inventive by nature. But into this new field he threw his whole energy and zeal with good results. As Seth Boyden was deficient in education he labored under many disadvantages. He had not the aid of a familiarity with technical treatises. The big words of scholastic books were constant stumbling blocks to him. But his acquaintance with Prof. Morse and Prof. Henry, of the Smithsonian Institution, in later years, were of valuable assistance to him in giving direction to his fertile but sometimes misdirected ideas. At the same time, his contact with such scientists and savants revealed to him the painful fact how much time and labor he had often thrown away patiently investigating and experimenting upon things which a better knowledge of books would have shown him were already known to the world. He had been often working in almost mental darkness so far as the helps of published data were concerned. But in all his researches and explorations he seemed to be guided by an intuitive knowledge of the existence of the hidden thing which he was determined to reveal. And he never wasted an hour upon any visionary object, only the purely practical and the useful attracted the thoughts and labors of this intensely practical mind. He was, not inaptly, called the "father of the machine business" in Newark. His experiments with the lightning-rod to prove his idea that electricity cannot all come from one direction confirmed his theory."

A TECHNICAL RAILWAY SCHOOL.

The Baltimore and Ohio Railroad Co. has issued an order for the establishment of a Technological school at Mount Clare, Baltimore, for the promotion of a higher course of instruction for apprentices than that now pursued. It is the intention to afford the young men in its employ an opportunity to obtain a technical education superior to the facilities enjoyed by the employés of other similar companies. Students will be divided into the following grades: the first or junior class, of apprentices; the second class, or cadets; and the third, or senior class of cadet officers. The expense of education is borne by the company, in return for which it expects to avail itself of the students' services, at fair salaries for at least three years after graduation. Upon entering the school, they will be paid according to the following schedule: Apprentices 70 cents per day the first year, 80 cents the second, 90 cents the third and $1 the fourth year; the cadets $1 per day the first year, $1.12½ the second, $1.25 the third year; cadet officers, $1.50 per day the first year, $1.75 the second, and $2 the third year. In their appointment, preference is to be given, all other things being equal, to the sons of employés who have been killed or injured in the company's service, and free tuition is given to those only who are sons of employés who have been five consecutive years in the company's service. They must pass a board of examination as to proficiency in elementary studies, and soundness in health. The line of studies to be pursued has not been made public, but the length of the course indicates that the intention is to found a school which will eventually give its graduates a high standing in the field which they are expected to occupy.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.

The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.

In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.

Sketches and drawings for illustrations should be on separate pieces of paper.

All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

CALCULATING RESISTANCE OF ARMATURES.

[38.]—Would you be good enough to explain what is understood to be the *resistance* of an armature. Such, for example, as an ordinary Gramme, in which the end of one coil is connected (by the commutator strip) to the beginning of the next.

For example: an armature has, say, 1,000 feet of wire upon it, the end of each coil or section being connected with the next. The resistance of 1,000 feet of the wire is 0.25 ohm. What is the resistance of the armature?—.25 ohm, .125 ohm or .0625 ohm?

Suppose the brushes to be in position on the commutator and the machine in operation, current will flow by the + brush out to the external circuit, back through the — brush, and through the armature. If it has to pass in series through the whole of the coils forming the 1,000 feet, the resistance must be .25 ohm; but does it not divide at the negative brush and return to the positive in multiple arc, each half of the commutator serving as a conductor and halving the resistance? Again, the distance to be traversed also being halved (500 instead of 1,000 feet) it seems that the resistance ought to be again halved, thus reducing the actual resistance of the armature to ¼ of what would be the resistance, in series, of its wire.

A SUBSCRIBER.

BOSTON, Mass.

[You are right in your understanding of the matter. The resistance of the armature is the resistance, in multiple arc, of the coils in circuit.

As Prof. Silvanus Thompson has shown (*Dynamo-electric Machinery*, p. 50, fig. 39), any ordinary armature of the drum or ring type may be regarded as acting like two voltaic batteries united in multiple arc or parallel, in which case the internal resistance is but one-fourth of what it would be were the cells placed in a single series.—EDITOR.]

THE AMOUNT OF POWER USED FOR ELECTRIC LIGHTING.

[39.]—Referring to a leading article on "Electrical Units" in a contemporary, in which it is stated that at the present moment there is not in the whole world 10,000 indicated h. p. used in the production of electricity, Mr. M. A. Miller, C. E., of Newark, N. J., writes:—"I should like to state that in the United States alone there is a greater amount of steam power used for electric lighting than four times the number of indicated h. p. stated. I can prove that but one of the leading electric light companies of the states, viz., the United States Electric Lighting Co., using the Weston systems, has arc and incandescent lights and dynamo machines running which use—

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For the city of New York, three stations........2,000 H. P.
Independent plants, including Brooklyn bridge.1,000 "
In different parts of the country, Independent plants.......... { Arc lights...5,000 " / Incandescent lights.....5,000 "
Local stations at Boston, Manchester, Providence, Newport, Rochester, Newark, Philadelphia, Baltimore, Washington, Charleston, Toledo, Ohio, and many other places..............10,000 "

Making a total for one electric lighting company alone of................................23,000 H. P.

That this statement is rather below than above the actual number of h. p. used for the Weston systems may simply be proved by the fact that there have been built up to the present time more than 2,000 Weston dynamo machines, requiring in the average each about 10 h. p. The United States Electric Lighting Co. has formerly also built about 500 Maxim machines, absorbing about 6 h. p. each, giving thus a total number of h. p. as stated above. Taking the Edison, the Brush, the Thomson-Houston, and half a dozen other electric light companies, into consideration, I think 40,000 h. p., used for electric lighting purposes in the United States alone, would rather be a low estimate than otherwise."

QUESTIONS AND ANSWERS.

[69.]—**Experimental Storage Battery.**—J. S. L., of Pittsburg, says:—I have some 16 c. p. incandescent electric lamps, requiring a current of 110 volts, $\frac{9}{10}$ ampère, that I wish to use, and intend making a storage battery for that purpose, similar to one mentioned in THE ELECTRICIAN AND ELECTRICAL ENGINEER (page 14, volume iv., "New forms of primary and secondary batteries"), as being composed of lead pipes rammed full of oxide of lead, etc. Would a battery constructed on this plan, weighing 150 pounds, divided into six cells of 25 pounds each, be large enough for current required? And would a bichromate battery of 12 cells, giving a current of approximately 24 volts, 1 ampère, at terminals, be sufficiently strong to charge storage battery in 10 to 15 hours with a current capable of running lamps four or five hours? **Ans.**—You can obtain but two volts from each cell, therefore for a 110 volt lamp, 55 cells would be required; but they can be very small if you need but .9 of an ampère. The battery you propose would not, therefore, produce the required results, neither would the primary charge it. As a rule, one square foot of surface per ampère will be a practical guide. For experimental purposes, the form you desire to adopt should be satisfactory.

LITERATURE.

RECENT PUBLICATIONS.

Harding, E. Hurren. Magnetic and Electrical Laws. London and Glasgow. *William Collins, Sons & Co.*

Hospitalier, E. Domestic Electricity for Amateurs. Translated by C. J. Wharton. New York. *W. J. Johnston.* 299 p; 155 cuts.

Stephen, Vincent. Wrinkles in Electric Lighting. London and New York. *E. & F. N. Spon.*

CATALOGUES RECEIVED.

The Bennett Telephone and Electric Co. of Indianapolis, issue a neat little illustrated catalogue, describing their various appliances to be used with the Bennett non-electric telephone. It is especially noticeable for containing no extravagant claims as to what the instruments will do, but is apparently based on facts.

Mitchell, Vance & Co., of New York, have issued a large catalogue copiously illustrated with beautiful phototypes of their elegantly designed fixtures for incandescent lighting. The goods represented are adapted to the fittings of the different electric lighting systems, or for both gas and incandescent lamps. Distant customers will experience no difficulty in making their selections from this book, the plates being reproduced from photographs and the dimensions of the fixtures given in every case.

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Underground Commissioners in New York and Brooklyn.—The Electric Headlight Appears in the East.—The Rival Ticker Systems.—Fire Alarm Systems, Old and New.

WITH the appointment of the three commissioners to enforce compliance with the Daly "underground" law, interest in the subject has to a great extent died out, although there appears to be little confidence that the interment of the wires will be hastened under the supervision of such experts as Jacob Hess, Charles E. Loew and Theodore Moss, who have been selected to determine what wires it is "practicable" to bury. The commissioners for the city of Brooklyn under the same act are gentlemen of recognized scientific and legal training, and have entered upon the work of organization with the idea of at least ascertaining the actual difficulties which confront them. At their first meeting the secretary was instructed to notify all electrical companies in the city of the organization of the board; to request from each of them its plan for placing its wires underground, or its reasons why they should be permitted to remain where they now are. These documents are to be accompanied by full details of the location of poles and conductors, and submitted by the 12th of August. Appreciating the difficulty of the situation, the commission proposes to permit the temporary erection of such wires as may be necessary, where they will not conflict with the future general plan of the underground system. In order to obtain all possible information upon the subject of subterranean electrical work, the following resolution was adopted:

Resolved, That this board invites from all persons or corporations interested in the adoption of a general underground electrical system, plans or suggestions in writing, and will grant special hearings in cases where after examination of the papers thus submitted it shall deem such hearings advisable.
That all communications intended for the board should be addressed to the Board of Commissioners of Electrical Subways, City Hall, Brooklyn.

A conference was subsequently held with the officers of the New York and New Jersey Telephone Co. regarding the wires in Washington street, but no decision was arrived at. It is said that hundreds of "best" systems have already been presented to the board. It is very probable that the technical knowledge of the Brooklyn commissioners will be of considerable value to the amateurs who are acting in the same capacity in this city. The careless manner in which this whole matter has been handled in the Legislature is proved by the recent announcement that there is some doubt as to whether funds are legally available to provide salaries for the commissioners, owing to a defect in the law.

The first appearance of the electric locomotive headlight in the East, was on one of the Lehigh Valley trains between Jersey City and Easton, on the 4th of July. It has proved a decided sensation along the line of the railway; crowds assembling at various stations to see it pass. The engineer is very much pleased with it, and its power certainly far exceeds the ordinary oil lamp. Its very brilliancy, however, is one of the objections to its general adoption on double track lines, for it is said to be impossible at times for the engineer running in the opposite direction to distinguish the switch signals ahead of him on account of the glare from the approaching arc lamp. As it is of far greater importance that every signal should be visible than that possible obstructions on the track may be detected, it appears somewhat doubtful whether the electric headlight will receive immediate official approval.

The efforts which have been made to deprive the Commercial Telegram Co. of its privileges in the Stock Exchange have not as yet proved successful. At a meeting of the governing committee on the 17th it was decided by an almost unanimous vote that the Commercial was entitled to equal privileges with the Gold and Stock company. Active preparations are being made for the introduction of the new Scott printers, and with their successful adoption, which is a matter of but a few weeks, the Gold and Stock company will be so far in advance, from a mechanical as well as a financial point of view, that it need have little fear of rivalry for many years to come. When this change is made, the operating room at 195 Broadway, and the carbon battery room at 8 Dey street, will both be vacated.

The fire departments of our larger cities are remarkable examples of the perfection to which mechanical skill and the faithful service of disciplined and intelligent men may bring a service in which every member is stimulated by the thought that merit will surely bring its reward. The fire alarm telegraph and the steamer have been such prominent factors in the modern system of fire extinguishing, that watchmen in fire towers have been looked upon as merely sentimental relics of the old volunteer service. That they are really useful, however, appears from the annual report of the Chicago fire department, in which it is stated that at least one-third of the actual fires in that city last year were discovered by watchmen in the old-fashioned towers. Such a record should be a strong argument in favor of the reestablishment of the tower system in every city, as an auxiliary to the fire alarm telegraph, which is occasionally deranged by severe storms.

NEW YORK, July 20, 1885.

BOSTON.

The Lowell Police Telegraph System.—Association of Electrical Linemen.—Serious Effects of Lightning in New England.—Distance at Which Thunder May be Heard.—Electric Lighting for Peru.—The City Fathers Too Extravagant in Using Telephones.—Proposed Electric Railway Privileges.—The Postal Company Ready for Business.—Resignations of General Manager Vail and Assistant General Manager Madden.

THE city solicitor of Lowell has presented an opinion to the committee investigating the subject of the introduction of the police telegraph in December, mentioned in a previous letter, and

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finds that the contract made by the committee on police and signed by the Mayor is not binding on the city. The committee has demonstrated that the system is impracticable, and that the price for it, $2,200 per annum for five years, is exorbitant.

The line-men employed in this city recently held a meeting for the purpose of organizing a mutual benefit association. There are so many electrical companies here that there ought not to be any serious difficulty in the matter.

The intense heat during the first of the month was followed by serious thunder storms throughout most of New England. Churches and other buildings towards which the fluid usually shows partiality did not escape; the damages being severe all around.

On Mount Washington, July 3d, a bolt of lightning entered the signal station at noon causing some damage, and badly injuring a railway employé James Camden. Both legs were paralyzed. The injured man was carried to the base of the mountain, and his feet placed in the ground. His friends had a theory that he was fully charged—not however as the good old hymn has it "A charge to keep I have," but one to be got rid of—and that the electricity would escape to earth when he was thus grounded. It is said the treatment proved successful to some extent. On the mountain after the storm the ground was covered with hail to the depth of an inch or more, and appeared snow-capped.

On the 9th a severe thunder storm passed over the city of Lowell, the lightning doing considerable damage. Telephone wires were struck, setting fire to the tower of the Telephone Exchange. The lightning arresters were not of sufficient conductivity to carry off the electricity and the wires were destroyed, completely interrupting the system. Not much injury was done below the tower, beyond burning a coil or two and giving the operators a sensation. The arresters probably saved the switch-boards and connections. It was but a few hours work to get in running order again.

An electric light trimmer while adjusting a lamp in East Boston on June 30th, met the current when it was turned on and received the full shock. When it struck him he was stunned, and losing his balance fell across the bar at the top of the light stand —and his wrist coming in contact with the wire was severely burned—causing however, no permanent injury. "No fault of the owners, the man only to blame."

Among the papers read at the 120th corporate meeting of the Boston Scientific Society, was one by Mr. H. P. Curtis on "Acoustics of Thunder." He said, that "contrary to the assertions of physical treatises, which hold that thunder is audible only 10 to 15 miles or possibly 18 miles from the generating flash, as the result of 10 years observations in Europe and here; he had heard thunder at a distance of 100 miles from the flash. Other observers had noticed flashes, and by timing the interval between flash and thunder, a distance of 150 miles was obtained."

A company, composed in part of gentlemen of this state and Connecticut, and in part of citizens of Peru, has lately been formed for the purpose of supplying the republic of Peru with the electric light, and will operate under exclusive grants from the Peruvian government for a period of 20 years, during which time all their electric lighting apparatus, machinery and other electric appliances will be admitted into the ports of that country duty free. These grants extend to and include the eight principal cities, viz.: Lima, Callao, Arequipa, Puno, Cuzco, Truxillo, Cazamara and Puira. During July a plant of 90 arc lights, from the works of the Thomson-Houston company at Lynn will be shipped to Peru. The company has already, it is said, received orders for apparatus from other cities and towns in Peru, but, under the terms of the grant, the electric light must first be introduced in Lima, the capital. Lima pays about $150,000 a year for gas, for which $3.20 in gold per 1,000 feet is charged. It is calculated that it will take 360 arc lamps to light the streets of that city.

At the meeting of the Board of Aldermen on the 7th inst., the Mayor sent in a communication announcing that the use of telephones in the city had cost $12,881.38 during the year, and that every department acts independently in their use. He is satisfied that there could be a saving of $7,000 to $8,000 per year if the telephone system was placed in the fire alarm department under the control of the superintendent of that department, thus making a saving of $100 per year on each telephone. The communication was referred to the committee on fire department. The following petitions were presented and referred: Bently-Knight Electric Railway Co., for leave to excavate the streets occupied by the tracks of the Metropolitan railroad, for the purpose of putting in operation its method of operating tramways; Boston Electric Light Co., for poles on Leverett and Brighton streets. An order was passed authorizing the Union Electric Light Co. to erect 12 poles in Lamson, Maverick and Bremen streets.

The Postal Telegraph Co. threw open its doors to the public on the evening of the 16th inst. at No. 4 Arch street, in the offices of the Commercial Cable Co.

Considerable surprise was manifested on the announcement of the resignation of Mr. Theo. N. Vail, general manager of the American Bell Telephone Co. He has been so thoroughly identified with the Bell Telephone company, that people had become to think that their interests were indissoluble.

Mr. Vail's history is characteristic of the young American of this age, when backed by energy and business ability. He was born at Malvern, Ohio in 1845. In 1865 he was in the employ of the United States Telegraph Co. In 1867 he was an operator in the Canal street office, at Morristown, N. J., and afterwards transferred to Newark; and in 1868 he turns up as an operator on the Union Pacific Railroad. In 1869 he entered the service of the government as mail agent between Omaha, Neb. and Ogden, Utah, at a salary of $1,000 per annum; and the same year was married and settled at Omaha, from which place he was transferred to Washington to act in the capacity of clerk, and was from time to time promoted. In February 1876, upon the death of Genl. Bangs, general superintendent of the railway mail service, Mr. Vail was appointed his successor—a position he held until his retirement to engage in the telephone business. Mr. Gardiner G. Hubbard was the first president of the Bell Telephone company, and having been connected with the United States post-office department, he there met and recognized Mr. Vail's ability, and through his solicitation Mr. Vail accepted the position of general manager of the Bell company.

Mr. Vail's capacity was fully proved in the early and severe struggles of the Bell company to throw off the Western Union entanglements, and to place his company on a business basis.

In whatever field of labor he may choose in the future, Mr. Vail will have the good wishes and cordial sympathy of a host of people to whom his name has become so pleasantly familiar by telephonic associations—and much more by personal association.

Mr. John E. Hudson, who succeeds Mr. Vail, while not so generally known, has been an associate in business with Mr. Vail for three years or more, as counsel and resident attorney for the company, and is entirely familiar with all the business of the company. Mr. Hudson is somewhat retired and grave in his demeanor, though he has a genial and wholesome disposition, and is in all respects a business man and a man of ability, and a worthy successor to the position of general manager.

Since writing the above, I hear of the resignation of Mr. Oscar E. Madden, who has been for so long a time ass't.-general manager of the Bell company. Mr. Madden entered the telephone service in the year 1878, before the telephone territory had been taken up. He was largely instrumental in the forming of the sub-companies, and has been to a great extent identified with the details of the business of the company; and no man has been more widely known in telephone circles. It is reported that Mr. C. Jay French, who has been a special agent of the Bell company at Chicago for some months will assume the duties vacated by Mr. Madden. It is an old saying "Speed the parting, welcome the coming." The telephone business remains, and has able and strong heads to perpetuate the work so ably commenced.

BOSTON, July, 18th 1885.

CHICAGO.

Experimental Test of Bare Wires Underground.—Evading the Indiana Telephone Law.—Incandescent Lamps for the Cook County Buildings.—The Legislative Bribery Story.—Special Electric Devices for Hospital Use.—Incandescent Lighting in the Theatres.—Ozone as a Disinfectant.—Serious Storms Throughout the West.—Criticism on Prof. Forbes's Distribution of Electricity.

In the last number of this correspondence mention was made of a test of the Dorsett underground conduit, which proved conclusively the insulating properties of the compound. The test, which was but an experiment, consisted in placing naked wires in one of these underground conduits for carrying electric light currents. The plant of 40 lights is still running successfully. While this proves conclusively that such wires may be safely run in the manner indicated, it was not intended to continue the arrangement permanently. The installation of the wires spoken of, where they are liable to dampness or other interference at the terminals of the pipe, was very complete, and the insulation rendered very thorough, by the following process, which is given for the benefit of those interested: The wire, before drawing in, was thoroughly taped from the union between the naked copper and the outside wire, for a few inches at either conduit terminal into the pipe. A cork, slit to receive the wire, was then placed upon this latter, and crowded into the end of the conduit about an inch. Then this counter-sunk space was filled with a compound which completely insulated the wire at the terminals of the tube, and made these air, water, and gas-tight, at the same time.

The Central Union Telephone Co. is earnestly combating the unjust law recently passed by the Indiana legislature. Their method of evasion, by charging for the use of lines, switch-boards, etc., is held to be a violation by the advocates of the law; while, on the contrary, the company insist that while they are making these charges, they violate no law or justice, inasmuch as only telephone rentals are governed by the late enactment. All new contracts are made for a period of three months only; and should the law be held to be constitutional, the company will quietly withdraw from the state, and remain out until the solons shall have come to their senses.

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A contract was recently entered into between this county—Cook—by its commissioners, and the United States company, by its Western manager, Mr. C. C. Warren, for the lighting of the county buildings by incandescent lamps. The following are the proposed plants:

County building	1,200
Criminal court	350
County infirmary	250
Asylum, old portion	320
" new wing	65
County hospital	1,300
A total of	3,485

lights. The successful bid for the above plants, which includes an expert's services for one month after completion, was $79,800. The Edison company's bid for the same work was $83,000.

Quite a hubbub was created in our state legislature during its last days of imbecility, on account of an affidavit of which the following is a copy:

"Frederick H. Tubbs, being first duly sworn, states that he is district superintendent of the Western Union Telegraph Co. at Chicago, his district covering most of the states of Illinois and Iowa, and that during the early part of the present session of the legislature, representative John H. Baker twice called at his room at the Leland hotel, Springfield, Ill., and offered to take care of (kill) his own bill, House bill No, 178, and stated that he could in all probability do the same for any other bills prejudicial to the interests of the Western Union Telegraph Co.

"He particularly mentioned Linegar's bill (144), taking —— per centage on gross receipts. He asked, as compensation, $500 at the time, and probably 'two' at the close of the session. He afterwards explained that 'two' meant $2,000."

The representative mentioned denied the statement of Tubbs in toto, and in the discussion ensuing and recrimination that followed, the main issue was lost sight of entirely, and both the proposed bills regulating the telegraph and the telephone enterprises, like small dogs in a general canine rumpus, escaped under cover of the dust and howls.

The Edison company, which lately placed a plant at the Wauwatosa insane asylum, near Milwaukee, in accordance with a request from the authorities there, has introduced a novel arrangement for regulating the light of the lamps in the hospital and other places where a full illumination is not constantly needed. Mr. Chas. Wirt, the company's electrician here, accomplished the desired result in a very simple and effective manner. The apparatus consists of five resistance coils of varying strength, which are cut in or out of the lamp circuit by means of a switch. A sixth contact cuts out the light entirely. The whole is mounted upon a small board which can be fastened on the wall or wainscoting, and is about 6 x 8 inches. The coils are inclosed in tin, and outside this is a wire cloth grating. Mr. Wirt also proposes using these as heaters for the patients, by attaching them by a flexible cord, so that they may be utilized in a bed, chair, or as a footstool. By throwing a portion of the current—say half a c. p.—through the coils, a gentle, constant heat is engendered, which requires no attention and needs no renewal, like a hot brick or a water bottle.

McVicker's theatre has been entirely reorganized throughout, and is now one of the most beautiful theatres in existence; 1,200 incandescent lamps illuminate the internal portion of the structure, and three outside arc lamps guide the pleasure seeker to this palace of Thespis.

Next in order among the list of places of entertainment to be lighted will be the "Battle of Shiloh," which is to be illuminated by the Excelsior people, and will be ready for business on the 1st of August. Almost immediately afterward, the Chicago Opera House, lighted by something over 600 Edison lamps, will put forth its claims to the amusement-loving citizens of Chicago and the strangers within her gates.

Speaking of cholera the other day, a well-known electrician of this city said that he had great faith in ozone as a disinfectant, and that if the dread scourge should visit the city this or next year, he had about made up his mind to purchase a good static machine for family use—for the good lady of the household to play with, and the younger members to experiment with, during the stay of the unwelcome visitor. Certainly, if there is the value in ozone which is ascribed to it, there should be a good demand for these instruments under such circumstances. Aside from its value in a scientific point of view, the confidence it would inspire in a family ought certainly to make it valuable, and a quite limited number of druggists' and doctors' bills would be sufficient to pay for one. It is a good time to test it, when cholera is around.

The entire Western country has been the scene of most violent storms, varying in magnitude from heavy thunder showers to cyclones and tornadoes, for several weeks. Chicago has been favored with several extensive exhibits of this nature. On the 27th of June we were treated to one of these displays, which played some funny pranks at Cheltenham beach, one of our "sea-side" suburbs. Lightning in this case struck a summer cottage, running down the chimney; thence dividing, a portion struck the contents of a gentleman's trousers-pocket, and coursed its way to earth through one leg of his garment, scorching this and ripping off the sole of the boot. The shock received was severe, but not fatal.

Another severe storm, which extended over a large portion of the northern states, was particularly severe in Wisconsin and Minnesota, tearing its way through the former state in a diagonal line between the southeast and northwest portions of the state.

On the 16th inst. still another of these fearful storms swept over portions of southern Minnesota and Dakota, while parts of northern Illinois and portions of Wisconsin also suffered. At Highmore and Holabird, Dak., the storm was classed as a cyclone, and the latter town was almost torn to pieces. Few lives were lost. Mr. E. B. Thompson, residing near Highmore, was picked up by the whirling monster and dropped, with his neck broken, about an eighth of a mile away. In the western belt of towns in Dakota, a district of not less than 18 miles wide, reaching into the Cheyenne valley, was visited a few days since by a storm which wound up with heavy hail, and destroyed great quantities of growing grain and other produce. Hail also fell in large quantities during the storm of the 16th, demolishing crops and window glass, at Manuel, about 10 miles below Grand Forks, Dak. The storm divided after this freak, and a portion of the cloud passed southwesterly, but the heavier part took the old beaten track through Polk county, Minn. Throughout its line of march the most vivid illumination was almost constant, and the rolling thunder was both fearful and persistent. A correspondent at Bismarck says:

"There was a wonderful display of lightning here last night (16th). The entire city was on the streets and in doorways watching the storm. The flashes followed so fast that people read newspapers on the street. It was the grandest scene ever witnessed in the country. The heavens were a continual blaze, and there was constant rumbling thunder; yet stars shone overhead."

The man has again made his appearance who offers to mix some chemical with feed water for boilers, to obtain steam at a lower temperature than 212°, and so save fuel, "you ll understand." He and the bi-sulphide of carbon enthusiast, the perpetual motion fellow, and the man who runs arc lamps with a battery, are a quartette that deserve a place in the front ranks of a first-class institution for the care of the feeble-minded; for, like the dying girl in the old song, altered to fit the occasion—

"They are almost there,
Or they soon will be,
When relief will come
To you and to me."

Popular Science News recently published a few words on the subject of steam power, which is worthy of being repeated in this connection. It says:

"The fallacy of all such schemes lies in considering that the steam or vapor developed in a boiler is the source of the power, when really all the force exerted by an engine is derived from the fuel in the furnace, and the steam or vapor simply serves as a means of conveying it to the pistons and wheels of the machinery."

There the truth lies in a nutshell, and the simplest mental pick may abstract it.

A curious source of error in weighing delicate quantities has latterly been discovered by a German, Mr. Hennig, of Wurzburg. Owing to a supposed error in results, Mr. Hennig made careful investigation, and found that the scales he was making use of were affected by the electrical condition of the rectangular glass shade which covered and protected the balance. The lever of the balance carries small sliding weights, called "riders," by which to obtain more delicate divisions than can be arrived at by arbitrary weights in the scale pans, and he found that wiping the glass shade above these produced sufficient electricity to raise them from the beam. Rubbing the shade lightly with a linen dusting cloth displaced the zero pointer several lines, while with silk or woolen cloth this error was materially less. The amounts of error thus engendered is shown as follows: After the first rubbing of the shade the electrical charge held balanced 600 milligrammes, and at the end of two hours still balanced a weight of 10 milligrammes; while with silk or woolen rubbers, under identical conditions of the atmosphere, the charge was balanced by 150 milligrammes and 70 milligrammes, respectively. The charge was dissipated by a Bunsen flame, instantaneously applied. Mr. Hennig purposes remedying the difficulty by attaching to the under surface of the glass shade a metallic grating with an earth connection, so that an accidental charge will be disposed of before it can do mischief.

In the July number of THE ELECTRICIAN AND ELECTRICAL ENGINEER, an article by Prof. Forbes, on "The Distribution of Electricity," is at variance with the results obtained by practical electricians here. He makes the statement that that form of multiple series installation, known as the three-wire system, will give a saving in copper of only 25 per cent. They claim that despite the endorsement of Dr. Hopkinson, the professor is wrong, and the "American financiers" are right, and base this assertion on the following: It is usual in America to figure electric light conductors as a certain per centage of the total resistance. The relation of the size of conductor to the current to be

carried is a separate consideration, not affecting economy, except where the size of wire approaches the limit of safety—which only happens when circuits are quite short. Now, take the case of four lamps and one dynamo, each lamp having a resistance of 1 on the multiple system, our joint resistance will be ¼. If we put the same lamp in multiple series with two dynamos, the joint lamp resistance will be 1. We have here multiplied our lamp resistance by four, used the same lamps, and given them the same energy. Clearly, then, we can multiply the resistance of our mains by four and lose the same per centage of energy in the conductors The third wire cuts no figure in the calculation, and its size is determined by the character of the service. Practically one-half the size of the + and — mains is ordinarily sufficient for the third wire.

CHICAGO, July 20, 1885.

WASHINGTON.

Destructive Fire Originating in an Electric Lighting Station.—The Scientific Opinion of the Fire Marshal.—The Central Plant to be Enlarged.—The Cooperative Lighting Scheme Abandoned.—The Philadelphia City Fathers Seeking Subterranean Information.—The Electrical Companies Beset With Difficulties in Running Wires.—Prospective Extensive Organization of Telegraphers.

ANOTHER destructive fire stands charged to the electric lights. It is true that under similar circumstances the same result would have been experienced in a cotton factory, planing mill or any other mechanical establishment. In other words the fire was caused by friction in the machinery and electricity had nothing to do with it. But it occurred in the works of the United States Electric Light Co., and with the unthinking public the electric light is charged with the destruction of the property that resulted.

About 8 o'clock P.M. on the 17th inst. a fire broke out in the engine room of the U. S. E. L. Co. which is located in the *Post* building, and spreading with great rapidity was not checked until it had destroyed four newspaper offices located in the same building, viz.: *Post, Republican* and *Critic* (daily) and the *Hatchet* (Sunday). The Sunday *Herald* and Sunday *Gazette* in adjoining buildings narrowly escaped. The story of the fire is graphically given by our worthy fire marshal as follows:

> The fire apparently originated from a heated journal on the main shaft, on which the person in charge emptied a can of oil, which immediately took fire, and was communicated to the broad leather belting running over the drum of said shaft and in close proximity to the journals. On this belting the same person threw water, and owing to the electricity in the leather the fire was spread.

It is to be regretted that he did not go into detail as to the manner in which the water and electricity from the belt combined to spread the fire, but as electricity already stands charged with the fire it is a matter of interest only to scientists.

The loss of the U. S. company will amount to about $50,000, insured for about $15,000. Its directors held a special meeting the morning after the fire and took steps for a speedy replacement of the machinery destroyed. The engines, boilers and other property of the Brush-Swan company, which has lain idle for several months, was leased, and permission to connect the works by air lines temporarily was obtained—four dynamos secured from the parent company in New York—and in five days from the fire the lights were all going again on the streets and in the departments. The company was able to do this without borrowing or issuing additional stock. Arrangements were at the same time made for enlarging the plant as soon as the necessary machinery can be manufactured.

Messrs. Lansburgh & Bro. have introduced the Thomson-Houston light in their extensive establishment and are much pleased with it. The idea of making a coöperative affair has been abandoned—Messrs. Sox & Co., who were to join in the enterprise, are now putting in as a private plant the Hochhausen Excelsior light in their new structure corner 7th st. and Pennsylvania avenue.

A delegation of the Philadelphia city councils visited Washington one day last week for the purpose of examining into the underground systems used here. They were shown every attention by manager Marean of the Western Union, supt. Miles of the Fire Alarm Telegraph, and general manager Bryan of the Chesapeake & Potomac Telephone Co. They went away with a good opinion of the Waring cables for municipal purposes but not fully converted to a general burying of all electric wires.

The Baltimore and Ohio Telegraph Co. propose to lay their wires underground from the depot where their air lines will terminate to their uptown offices, a distance of about a mile and a half. Negotiations are now pending with the commissioners as to the route.

In the matter of the injunction suit against the Western Union Telegraph Co. to restrain them from maintaining a new line of poles on 7th st., in which is involved the question of the commissioners control of the streets, both, or rather all three sides, are busily engaged taking testimony before a U. S. commissioner preparatory to a final hearing before the full court some time this fall. The telephone people are waiting the decision and will lay no more cables until their right to put up distributing poles in the alleys in the centre of a block is established. This permission was given them by the commissioners in consideration of the substitution of underground for overhead wires along the streets.

As matters now stand the companies find it less difficult to keep their poles where they are than to attempt any change that may bring them before Judge Hagner. The house-top wires seem to be the only ones beyond the reach of the courts and commissioners and even these are not always safe. One by one wires had been strung over the Treasury building by telegraph, telephone, electric light and messenger companies until a regular web was woven over the roof of the building. This appeared so unsightly to Secretary Manning that soon after coming into office he notified all the parties interested that unless their wires were removed by the first of July they would be cut away. The telephone people in carrying out their cable scheme had underground wires ready by the time fixed, but had left about a dozen dead wires on the building. The others paid no attention to the order and were somewhat surprised when the day named came to find every wire cut loose and coiled up to the nearest bracket or pole with the insulators, frames, brackets, etc., piled up alongside of them.

The operators generally are much pleased to find that the existence of the Bankers and Merchants' and the Postal Telegraph is to be prolonged for a while at least, regarding their competition as to some degree a safeguard against a wholesale reduction of wages. Their demise would probably be the signal for the formation of a league or union more formidable than any the Western Union has heretofore encountered. The other trades unions are beginning to see in the telegraph a weapon of great power, if properly handled, and one that can be wielded at comparatively small cost when a question involving the general interest is at issue.

WASHINGTON, July 23, 1885.

PHILADELPHIA.

Excellent Prospects of the Novelties Exhibition.—The New Telephone System of the Fire Department.—The Clay Commercial Telephone Plant Sold at Auction.—The Wire War.—The Western Union Main Operating Room Burned Out.

SPACE at the Novelties Exhibition, to be held under the auspices of the Franklin Institute, is rapidly filling up, and the indications are that applicants will be very much cramped. The building is undergoing a process of reconstruction in the inside since the dynamo and incandescent tests were finished, which have been going on there, until recently, since the close of the electrical exhibition. The buildings will be greatly improved, and the space for exhibitors made suitable for their convenience. The committee on exhibitions has been daily in receipt of applications from exhibitors for space. An interesting feature will be (for the first time at any exhibition) the complete exposition of the capabilities of "water gas." It will be demonstrated how from a single line of pipe laid through a city, the inhabitants may supply themselves with heat, light, and power for all purposes, at a smaller cost than with the present methods. Another instructive feature for which arrangements have been made will be a complete and extensive exhibit of the art of silk culture, from the egg of the silkworm to the finished products of the loom. This exhibit will be made by the Women's Silk Culture Association.

The Feister printing press will also be among the extraordinarily remarkable of the exhibits. This will be the first time that this press has ever been seen in public. The press prints from an endless roll, on both sides; folds, pastes and covers the printed sheets, and turns out pamphlets at the other end bound and ready for mailing, without any hand work whatsoever, at the rate of 5,000 per hour. Another of these interesting exhibits will be Mr. Holland's process of working and manipulating the rare metal iridium. This process is an important one. It solves completely the problem of fusing, casting, dividing, drilling, grinding, and the other workings of the most refractory and hardest of all metals. In addition to the exhibitions of Professor Lowe and the Siemens, the Albo-carbon gaslight, which presents a novel mode of enriching ordinary coal gas by the use of naphthaline, a hydro-carbon, which is produced in large quantities as a by-product in the manufacture of coal gas, will be on exhibition. Otto & Clark will show their latest devices in gas engines and domestic motors. Among the miscellaneous exhibits, the cyclostyle, a new process of multiplying the impressions of letters and drawings, will be shown, together with scores of many others of equal worth. During the exhibition the machinery will be kept constantly in motion.

Within a few days past superintendent Walker, of the city's electrical department, has introduced a telephonic system of fire alarms which will greatly enhance the efficiency of that service. The object of the new system is to prevent mistakes which are liable to occur with the ordinary electrical apparatus in transmitting alarms. It acts independently of the old method, and comprises seventy miles of wire connecting each fire engine and truck house with the patrol stations, chief engineer's office, and the electrical department. There are from three to

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seven engines in each of the eleven circuits, and the chief engineer can go to any box and communicate with any engine house and can order any particular engine or hook and ladder company to any locality. The tests made were perfectly satisfactory. Engine houses in Manayunk (ten miles away from the central station) were called up and spoken to, as were also engine houses in Chestnut Hill, Southwark, and other parts of the city. Telephone messages from the central station pass through the main office, but messages from the engine houses do not reach the central station until after they have been received at headquarters. At 6 o'clock in the morning, and at noon, the exact time will be sent to all the engine houses over the new wires. The system cost $1,900 less than the price at which the Bell company agreed to furnish instruments for, and will save thousands of dollars each year.

A constable's sale of the effects of the Clay Commercial Telephone Co. used in the operation of the exchange on the sixth floor of No. 302 Chestnut street, was held on July 7th. The sale was to raise money for rent, amounting to $333.35, which was due and unpaid. Superintendent F. W. Smith said that the company was in good financial condition, owing not more than $5,000 in the city, but that the directors, in view of the uncertainty of affairs pending the decision of the court in the suit brought by the Bell company for alleged infringements of patents, were unwilling to put more money into the concern.

The instruments and attachments sold were worth, according to Mr. Smith's estimate, nearly $10,000 to the company; but as only $50 was realized at the sale, it is quite certain that they were worth very little to the general public. Exit the Clay Commercial Telephone Co. Next!

Operators of the Bankers and Merchants' Telegraph Co. found something wrong with their instruments about 10 o'clock on the night of July 10th. First the operator who was sending to Baltimore noticed the sudden stoppage that indicated a break in the circuit, and then at intervals of an hour the New York wires refused to work, the wire to Pittsburg broke down, and then, one after another, the extra wires which had been brought into service to those places, gave way also.

The Bankers and Merchants' company here operated all the old American Rapid wires, and in addition, a number of their own. They had four wires to Reading, originally the property of the Lehigh Telegraph Co,, and four American Rapid wires to Baltimore, which came into the city past the testing station near Darby. These wires went down first.

There were four Rapid wires to Pittsburg, and six Bankers and Merchants', all of which were cut west of Harrisburg. Seven Rapid to New York, and 22 Bankers and Merchants' on the same poles, between which a discrimination was made, and the Rapid only cut. Single wires to Kensington and Broad street, both Rapid, were cut. The line from Baltimore to Harrisburg was also cut south of York.

By the crossing of an electric light wire with one of the telegraph wires leading into the operating room of the Western Union office, on the top floor of the magnificent Mutual Life building, at 10th and Chestnut streets, at 2:15 A. M., July 18, the switchboard, holding over 400 wires, was set on fire and the entire office burned out. Night manager Louis D. Maize was just in the middle of a despatch from New York when he perceived a blue flame among the wires. He sprang to the switch-board and began cutting out the burning portions, but the flames gained rapidly and the woodwork around the wires was on fire in a few moments. An attempt was made to use the fire extinguishers provided for emergencies, but they would not work.

The engines arrived within a very few minutes after the discovery of the fire, and the flames were then bursting from every window of the large operating room, leaping in long tongues over the sloping Mansard roof of the building. Night manager Maize tried to save some of the furniture of the office, and escaped from the blazing room with some slight scorching.

Within three minutes after the switch-board was discovered to be on fire, the entire room was filled with a volume of roaring flame.

The whole plant of the main operating room was destroyed, and an official of the Western Union said that $10,000 would hardly cover the loss on instruments, furniture and fixtures.

After the firemen got their ladders up and brought streams to bear on the flames, the fire was quickly gotten under control.

While the fire was raging under the Mansard roof, manager Maize climbed upon the top and connected an instrument with a wire to New York. The message which he was engaged on when the flames spread through the operating room, was finished.

PHILADELPHIA, July 18, 1885.

SAN FRANCISCO.

An Inspection of Apparatus by an Eastern Electrician.—Improved Condition of Duplex and Quads.—A Further Inspection Outside of the Electrical Field.—The Mysteries and Miseries of Chinatown.—A Sewing Machine Motor Service.—Dr. Keith's Electric Railway.—Rumored Changes in the Western Union Service.

THE advent of Mr. Gerritt Smith on this coast caused considerable of a flutter in telegraphic circles—for his fame—as well as his modesty, preceded him; hence from Mr. Smith much was expected and much good has he done. It is difficult to work a quad on a wire which embraces at different parts, three gauges, viz: 6, 8, and 9, as well as being poorly insulated, yet Mr. Smith's three coil relay enabled us to do it (at least for a day or two), and it may be tried again, when only one wire is left us, till then we find it hard enough to work duplex to Ogden. Sometimes the quad on a No. 6 gauge wire is used between Virginia City and Ogden, and two duplex west of Virginia to San Francisco; even in this way we find much trouble in getting Ogden clearly. Whether, this is caused by bad batteries or poor attention, is for electricians to determine, I am not an electrician; but I do say, an occasional visit from such men as Mr. Smith would be productive of an infinite amount of good, by obviating unnecessary profanity on the part of exasperated operators.

With Mr. Smith himself, it was *veni, vidi et admirate.* He basked in the sun, at the foot of the orange trees and drank lemonade with Rufus Haines at Los Angeles. He was only two days behind a stage robbery on the road to Yosemite, and then he saw the Yosemite valley and would have left us without a glimpse of Shanghai and Canton, had it not been that an operator who was aware of Mr. Smith's wonderful power of concentrating ideas and producing results, almost forced him to see our miniature "flowery kingdom." He first visited that portion of which Beecher and Talmage gave such glowing descriptions. Thence through the retail portion of Hong Kong, drinking tea with Chong-Foo in the boudoir of Li Fong (or "The lady of the lake"), reclining on the sedan (extension sofa) of the once famous empress Li-yuen-pin and propitiating the pagan gods of fortune in the temple of Joss. Then he saw the tragedy of Tuni-mah-ka hi (The Black Thief and The Knight), enacted in the royal Li-hip-wo theatre—thence passed through many subterranean passages and "cologne alley," to the temple of Chinese statuary. Here, I might add, Mr. Smith for the first time manifested surprise—for he did not believe that the Chinese were so well advanced in sculpture; but when he saw the Venus of Hi-wah-mo, an artist, according to Dr. Li-po-tai, who so far surpassed all others of his time, and since—that his memory is canonized in the hearts of his countrymen—Mr. Smith stared in downright admiration and surprise.

It being Saturday night and as all places of amusement are closed by midnight, he determined to see the Chinese receiving and forwarding hospital. He was fortunate in finding in the receiving room an invalid who awoke as a light was struck in this dark chamber. By the aid of a taper he could see the patient was suffering from yit-ong, commonly called leprosy. That which you call "a rose by any other name would smell as sweet" Mr. Smith did not find it so—he had no fears of the yit-ong disease till the name was translated into the language of the "red devils" *leprosy*—Ah! It was then the finer nature of Mr. Smith arose in rebellion. He was prevailed upon to see the other chamber—a Chinaman had just died uncared for by living soul, none to close his eyes or repose his features, but left to stare in all the ghastliness of death—Mr. Smith could contain himself no longer; he said to one of his companions: "A Methodist minister in our town told me to be sure and see Chinatown. I have seen it, and I will never forget it. Steve Field has told me some stories, about it but I knew him to be an inventor, and hence thought his imagination might also be of an inventive turn in this regard, but that minister shall know now that I have seen Chinatown. I could forego the orange groves, the geysers, big trees, the wheat fields of San Joaquin, the vineyards of Senoma, the Cliff House, and all, but not Chinatown."

A company composed of some prominent gentlemen is being formed to run sewing machines by electricity on the Stockwell system, which is being now so successfully used in Philadelphia. This city offers a fine field for such a system, and it is being worked up by competent, energetic gentlemen whose names in connection with any electrical enterprise commands confidence and attention. It will be a boon to the women of San Francisco, and even to the coolie slave.

Nothing has been heard of late of Prof. Keith's electric railway although it was whispered that two experiments were not wholly satisfactory. Mr. Keith is sanguine, however, as is also Mr. Isaac Trumbo, his associate, who assured me that motors and dynamos were all ready and that the plan was entirely the idea of Mr. Keith, who proposed to take electricity from two wires laid between the rails. I have been assured a public exhibition would be given at an early day.

E. A. Beardslee is coming here ostensibly to work as an operator for the Western Union, but really to acquaint himself with the details to be ready to take hold when the time comes. Strange rumors are afloat, vague, but with a semblance of reality to back them up, that changes will take place, and changes that are to be deplored. Col. Clowry with his family, J. J. Dickey, C. H. Summers and a few notables are coming in a special car. Col. Clowry, it is said, with a pruning knife in hand.

SAN FRANCISCO, July 1, 1885.

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ELECTRICAL NEWS AND NOTES.

TELEGRAPH LINES SEIZED WITHOUT NOTICE.

On Friday, July 10th, about 3 o'clock, General Eckert, representing the Western Union Telegraph Co., waited on General Farnsworth, receiver of the Bankers and Merchants' Telegraph Co., in this city, and presented an order from Judge Donohue, directing him to turn over all the property belonging to the American Rapid Telegraph Co. As is generally known, these lines had been leased to the Bankers and Merchants' company on the agreement that 6 per cent. yearly interest would be paid to the bondholders of the American Rapid company, and as the interest was not paid up, the stockholders became dissatisfied and accepted the proposition of the Western Union for a lease with similar terms. Gen. Farnsworth refused to turn over the wires until he had consulted with his attorneys to find out exactly what the property of the American Rapid company consisted of, and what belonged to the Bankers and Merchants' company, as the property of the two companies has been almost inextricably mixed up by running the wires of one over poles belonging to the other.

About half an hour after the order had been presented to him, Gen. Farnsworth was astonished to find that several wires were dangling in front of the building occupied by the Bankers and Merchants' company, at No. 187 Broadway. He found that Gen. Eckert had entered the building with a number of men, and had detached all the wires belonging to the American Rapid company on the cupola of the building, and also all owned by the Bankers and Merchants'. These wires were then being carried into the Western Union building, on the corner of Dey street and Broadway.

Mr. Lauterbach, of the firm of Lauterbach & Spingarn, attorneys for the Bankers and Merchants' company's bondholders, applied at once to Judge Donohue for a stay of proceedings. The application was granted, but not until the wires had all been taken into the Western Union building.

It would have been an utter impossibility for any Western Union employé to hastily select out of a hundred or more wires the exact ones which were the property of the American Rapid company, and no attempt was apparently made to do so, except, perhaps, under the general understanding that the only lines actually owned by the Bankers and Merchants' company were those leading south from this city and terminating at Washington. It appears, however, that there were wires of the latter company upon poles of the American Rapid, running through the state to Buffalo. No attempt was made to conceal the fact that the Bankers and Merchants' system was thoroughly crippled. On Saturday morning the public was so thoroughly informed of the shattered condition of the service, that little business would have been offered, even if it could have been transmitted. Under its harmonious relations with the Postal company, the transfer of such messages as were offered to accessible points was readily effected, but there were a number of wires leased to merchants and brokers, who were dependent upon them for the prompt transaction of their business. Such cases caused still greater annoyance, but no alternative was presented but to calmly await the process of law. About 30 eastern and 50 city wires were cut, 12 between Harrisburg and Pittsburg, also the wires at Buffalo, Rochester and Baltimore, under direction of the Western Union local managers at those points. The Bankers and Merchants' lines were carrying a large business at low rates, and it was evidently more the purpose to cripple the facilities of the company than to acquire them for the use of the Western Union. Not the least of the troubles was the probable loss of employment by perhaps 100 operators, although it was not deemed prudent to allow the force to become scattered until the question as to future operations was definitely settled.

The statements of Gen. Farnsworth and Edward S. Stokes—the latter a large bondholder of the bankrupt Bankers and Merchants' company—were to the effect that the linemen of the Western Union company gained access to the roof through an adjoining building. Mr. Stokes, who was found by a *World* reporter in a high state of indignation, said: "It is one of the most high-handed outrages that has ever been perpetrated upon the public, whose sympathies, I think, will be with us. It was a gross outrage when the Western Union company tampered with and manipulated the election returns in an endeavor to defeat Cleveland's election, but this last act of that corporation is even more atrocious, if that be possible. It was a deep-laid conspiracy," he added, "the parties to which you may guess from the facts which I will relate. And the strange part of it is that Judge Donohue, who issued the last order, was the very magistrate who, over the seal of the Supreme Court, issued the order for receivers' certificates, which were offered on the market, and of which I bought over $400,000 worth, paying cash, most of the property going into the possession of the company, whose possession he has now, without any notice to me, put into the hands of the Western Union.

"The way in which it was done is as follows," continued Mr. Stokes. "The Western Union ascertained last week that our reorganization committee was a success, and that three-fourths of the holders of $10,000,000 of our first mortgage bonds had agreed to the plan for protecting the property of the company, which was to sell the property and buy it in for the benefit of the bondholders, when a new company, the United Lines Telegraph Co., would be organized. This sale was to have taken place July 10th, and had been advertised for a month. A party, however, who would not give his name or tell who he represented—although we believe he acted for a man named Powers, who owns 200 of the bonds—made application to Judge Donohue to have the sale stopped. The bondholders, of course, opposed the application, offering to give a bond for ten times the amount in indemnity, but, much to their surprise, Judge Donohue granted an order postponing the sale. This he did Thursday, and he supplemented it Friday by granting this other order, when it is an utter impossibility for any one to separate the lines of the American Rapid and the Bankers and Merchants' without great study, as they are so intermingled.

"So interlaced were these lines that, as the Bankers and Merchants' had $2,000,000 invested in the American Rapid company, there was a suit pending to determine how the matter could be settled or compromised. Then, at almost the same time that Gen. Eckert presented the order to Receiver Farnsworth, a force of about 40 men in the employ of the Western Union, all armed with axes, get up on the roof of our building through the adjoining house, and, breaking the skylights, proceed to cut all the wire—American Rapid and Bankers and Merchants'—and to carry the cut wires into the Western Union building, so that it is impossible for us to repair the damage. Then, when our counsel goes before Judge Donohue, the latter admits that he may have acted hastily in the matter and made a mistake; that he regretted the inconvenience to which his order had put us, but that as the damage had been done, it was past all interference on his part, and that now it was a matter for litigation. That was a rather strange proceeding on the part of Judge Donohue, wasn't it, and also a strange admission for him to make after our wires had been cut in this manner and on his order?

"The Western Union now claims," concluded Mr. Stokes, "that this last move has effectually done away with all competing companies, and now they will not be troubled by any rivalry. That is the whole secret of the affair—it was done to frighten the people from putting any money into the telegraph business, as against the Western Union. It is impossible for us to estimate what loss this will cause us, for it will be impossible for us to repair the damage for months, unless we return like with like, and with an armed force enter the Western Union building and take out our wires. That we do not care to do."

Mr. Dwight Townsend, chairman of the Bankers and Merchants' Reorganization Committee, will call a meeting of the bondholders to be held as soon as possible, in order to consider the matter and lay the facts of the case before the grand jury, and he says that no expense will be spared to bring the perpetrators of this outrage to justice.

The penalty for illegal interference with telegraph wires is unusually severe, and during the troubles which have occasionally beset the Western Union company, its managers have freely threatened their adversaries with the terrors of the law, which is as follows:

> A person who wilfully or maliciously displaces, removes, injures or destroys a line of telegraph, or any part thereof, or any appurtenance or apparatus connected with the working of any magnetic or electric telegraph, or the sending or conveyance of messages by any such telegraph, is punishable by imprisonment for not more than two years.

Not only the person who commits the act, but also any one who orders or causes it to be done, is guilty of the crime, and may be punished. Section 29 of the Penal Code says:

> A person concerned in the commission of a crime, whether he directly commits the act constituting the offence or aids and abets in its commission, and whether present or absent, and a person who directly or indirectly counsels, commands, induces or procures another to commit a crime, is a principal.

The order granted by Judge Donohue on Friday, directing the transfer of the wires of the American Rapid Telegraph Co. to the Western Union, was made upon the motion of Dillon & Swayne, attorneys of the Western Union, upon a petition sworn to by Dr. Norvin Green, president of the Western Union. The motion was made in the suits brought against the Bankers and Merchants' company, of New York, New Jersey, Pennsylvania and Baltimore, by Austin G. Day, Alexander H. De Haven and the Farmers' Loan and Trust Co. The petition of the Western Union company stated that on July 1, Judge Shipman, of the United States Supreme Court, had made an order vacating an order previously granted, thereby permitting Edward Harland, receiver of the American Rapid company, to make such traffic arrangements or lease with other persons or corporations as he might consider to the best interests of the stockholders. It was in pursuance of that authority that Receiver Harland made a contract with the Western Union to manage the lines owned by the American Rapid company. The petition further stated that the

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Bankers and Merchants' Telegraph Co. had no lease, contract or agreement entitling it or its receivers to the possession of the property of the Rapid company.

An affidavit of Frederick H. May, director of the American Rapid Telegraph Co., was attached to the Western Union's petition. Mr. May declared that the Bankers and Merchants' had no lease or contract entitling it to hold the property of the Rapid company.

Upon all occasions of this kind, Mr. W. B. Somerville appears to act as the official mouthpiece of the Western Union Telegraph Co. When others are reticent he is exceedingly loquacious, not only regarding the affairs of his employers, but of their competitors as well. In an interview upon the subject, he is reported as follows:

"The placing in our hands of the Rapid company's wires is merely what Mr. Edward Stokes and other stockholders of the Bankers and. Merchants' have been trying to do with their own property. They would have turned over to us at the same time the Rapid company's wires, but they are angry that they have not had their stock taken. The Baltimore and Ohio company has been trying to do the same thing for the past two weeks, and is still endeavoring to get us to take their wires. We took about 100 wires from the B. and M. building, but we have not as yet even made a schedule of them."

"Will you use the wires?"

"No, not until after July 14, at all events. The injunction granted by Judge Donohue last evening, and which was served upon Dr. Norvin Green by H. J. Schenck, the attorney for the Bankers and Merchants', prevents our doing anything with the property until the matter comes up before the court on Tuesday. We do not believe we have taken a single wire belonging to the Bankers and Merchants', as they claim, 'but should we have done so by mistake they can recover for any damages done.'"

The above statement in reference to the Baltimore and Ohio company drew out the following card from President Bates:—

To the Editor of the World:

The statement in Sunday's *World*, attributed to Mr. Somerville, of the Western Union company, that the Baltimore and Ohio company has been trying for the past two weeks and is still endeavoring to get us (the Western Union) to take their wires, is absolutely false. I have had no conference or communication with the Western Union company or any of its officers for months, and never at any time on the subject of a union with that company. The Baltimore and Ohio Telegraph Co. is controlled by the Baltimore and Ohio Railroad Co., and Mr. Robert Garrett, president of the latter, cabled me from London last Friday to deny the false statements. I sent a denial at once to the office of the New York Associated Press, but as the item did not appear in Saturday's New York Associated Press papers, I infer it was for some reason suppressed.

D. H. Bates,
President of the Baltimore and Ohio Telegraph Co.
West End, Long Branch, July 12.

The following is the substance of the statement presented before Judge Donohue by the counsel of the Bankers and Merchants' company, giving a general history of the growth of the system, and the damages sustained by the transfer of wires without proper notice:—

"The Rapid company's original system comprised a line of four wires from New York to Boston via Bridgeport, New Haven and Hartford. The poles were small and the wire inferior. Another line of four wires, by way of Hudson and Springfield, connected this city with Boston. From New York to Albany and Buffalo there was a line of six wires, and from thence to New Castle, Pa., an equal number most of the way. Four other wires connected New York with New Castle, via Philadelphia, Harrisburg and Pittsburg. Between New York and Philadelphia were three additional wires, thence to Baltimore six, and between there and Washington four. Baltimore was connected with Harrisburg by two wires. The farthest point west reached was Cleveland, and four wires connected that city with New Castle. All of the lines were built along the highway, and the Rapid's plant between New York and Philadelphia was of little account, as it ran through the trees and back yards.

"The Bankers and Merchants' original line comprised 22 wires to Philadelphia, 10 from there to Baltimore, and 8 thence to Washington. After amalgamation, the company added 14 wires on entirely new and substantial poles via Meriden, Hartford and Providence, to Boston. This was completed six or eight months after the amalgamation. Four extra wires were put up between Meriden and Hartford, and two from Meriden to Waterbury, Conn. The original four Rapid wires from Meriden to Boston were transferred from the old poles to the new pole line on account of the poor condition of those on which they were stretched. New London was connected with the system by a line of four wires from Willimantic, Conn. From the main line at Providence another of four wires was constructed to Newport via Fall River. On the poles supporting the six Rapid wires from New York to Albany and west to Buffalo, the Bankers and Merchants' added four new wires to Hudson, six from there to Albany, two to Utica, and four thence to Buffalo. They also placed on the Rapid poles from that city to New Castle four new wires. Between Philadelphia and New Castle six wires were added, and to Cleveland from that point six new ones were put up. Four wires were stretched from Baltimore to Harrisburg on the Rapid poles. The Western system was extended to Chicago from Cleveland, and a new and substantial pole line was erected bearing 10 wires. A very extensive and costly underground system, said to be the best in the world, was established in Chicago. No elevated lines are worked there, the wires being carried underground from 39th street to the main office in Madison street, near La Salle street, and to the branch offices. At the junction of the main line at Freeport, O., a branch with six wires was built to Toledo, and four from thence to Detroit. From Pittsburg a line of four wires was built west to Indianapolis via Cleveland, which closely follows the Panhandle railroad route. A branch of four wires from there to Cincinnati is just finishing. From Chicago to St. Louis the Bankers and Merchants' are in control by lease of the Board of Trade Telegraph Co., with three wires. Three additional wires were afterwards stretched on the same poles. They control two wires of the Pacific Mutual company from St. Louis to St. Joseph, Mo., via Kansas City.

"These lines are now cut off from the Eastern system. In almost all instances where new wires were put on, new instruments took the place of those in use by the Rapid company. New switch boards and furniture have been put in to accommodate the increased business.

"In this city messages were delayed by being transferred to other companies for transmission. The following private wires were also cut: Samuel Crump, to Montclair, N. J.; W. T. Hatch & Son, to New Haven; United Press Association, E. Sweet & Co., to Boston; L. Cahn & Co., to Boston; Charles Head & Co., to Boston; Seymour, Baker & Co., to Fall River, Mass.; *Inter-Ocean* Publishing Co., to Chicago and Washington; C. W. Brega & Co., to Chicago; Colbron, Chauncey & Co., to Boston; E. P. Schmidt, New York city wire; Chase & Higginson, to Boston; E. K. Willard & Co., to Boston; Taintor & Holt, to Boston; and Kidder, Peabody & Co., to Boston."

The following explanation of the action of the Western Union company was telegraphed to the superintendents and managers at all offices reached by the American Rapid Telegraph Co.'s wires:

The United States Circuit Court, in the suit of the trustee for the bondholders against the several American Rapid Telegraph companies, appointed Edward Harland receiver, and ordered that he take possession of the properties belonging to those companies, the Bankers and Merchants' company being also in the hands of a receiver under proceedings in the Supreme Court of New York, such receiver having or claiming possession of the American Rapid lines, although the order of appointment of the receiver of the Bankers and Merchants' company was limited to the property of the Bankers and Merchants', and did not extend to the property of the American Rapid company. A contract was made by which the Western Union Telegraph Co. is made the agent and attorney of Edward Harland, receiver of the American Rapid Telegraph Co., to take over and operate the lines. Therefore, application for possession was made to the Supreme Court, and an order granted directing the receiver of the Bankers and Merchants' company to turn over possession of the Western Union Telegraph Co., and authorizing the Western Union company to take possession of all the property of the American Rapid companies, and under that order most of said property has been taken possession of. On the night of the 10th inst., upon allegations of the receiver of the Bankers and Merchants' company, the Supreme Court made a further order directing that all further steps towards taking possession under the previous order be stayed until a hearing of both parties, set for the 14th inst., but not requiring any property in possession of the Western Union company, as agent of the American Rapid company, to be returned. (Signed), Norvin Green, President.

To offset this the Bankers and Merchants' representatives exhibit a written agreement, which they claim has been carried out by them in every particular, and that they owe nothing for the rental of wires. No notice has been served upon them by the American Rapid company that the latter desired to terminate the contract.

The agreement is signed by President A. W. Dimock for the Bankers and Merchants' company and by general manager G. S. Mott, of the American Rapid company, and is sealed and attested by J. G. Case, secretary of the former company. It is as follows:—

This agreement, made this 18th day of October, 1883, between the Bankers and Merchants' Telegraph Co., party of the first part, and the American Rapid Telegraph Co., party of the second part, witnesseth:—

(1) That each of the parties hereto gives unto the other the right to string wires upon any of the telegraph poles owned by it, and to use, maintain and operate such wires in the conduct of its business.

(2) Each company so placing wires on the poles of the other shall pay as a yearly rent $4 per mile of wire, such rent to be paid semi-annually, and if such rent shall not be paid, it is understood and agreed that said company may direct the other to remove said wires from its poles; and, if said wires are not so removed within six months after such notice, they shall become the property of the company upon whose poles they were placed.

(3) The right hereinbefore granted is expressly limited as follows:—

1. No wires shall be placed on any poles without the written consent of the company owning such poles first being obtained.

2. Such wires shall be strung under the wires then upon such poles, and shall be so strung, maintained and operated as not to interfere with the working of the wires of the company owning such poles, and each party hereto agrees to pay within twenty days after demand in writing made upon the superintendent of the district wherein any such injury may occur, the amount of any damage to the poles or wires of the company owning the poles upon which the other party heretofore may string wires, caused by the placing thereon of such wires and their necessary cross arms, under penalty of forfeiture of all right to keep and maintain its wires on the poles of the other party on the line where such injury shall have been sustained.

(4) Taxes assessed on polls and wires in all places shall be paid by the parties hereto ratably in proportion to the number of wires of each on the poles so assessed.

(5) Either party to this contract may after ten years from the date hereof terminate the right of the other to use its poles as herein described upon six months' written notice to the other, and if, after the expiration of the said six months such wires, with their cross arms, &c., shall not have been removed the

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company owning the poles shall have the right to remove said wires, cross arms, &c., at the expense of the other party heretoor, at its option, to acquire and own the same after paying therefor $200 per mile per wire.

President D. H. Bates, of the Baltimore and Ohio company, is as well acquainted with the history of Western Union's methods of crushing out competition as any man in the country. Referring to the raid he said:—"The outrageous conduct of the Western Union in seizing by force the property of a rival company and then coolly saying to them, 'You have your remedy in the courts,' is only paralleled by the lawless deeds of this monopoly on a similar occasion.

"About ten years ago the Merchants' National Telegraph Co. had a line between Pittsburg and the oil regions of Pennsylvania. It was a short but important line, on account of its valuable connections with the cities and towns in the oil country. The property of the company was in the hands of the Western Union company, under a lease for ten years. Just before the lease expired, ten years ago, the Atlantic and Pacific Telegraph Co. bought a controlling interest in the stock of the Merchants' National, with the intention, of course, of adding its lines to their service. At that time the Atlantic and Pacific was competing with the monopoly company and was building up a good business.

"The Western Union seeing a valuable line about to pass out of its hands, resolved upon a desperate step. About a week before the lease expired, when that line would pass into the hands of the Atlantic and Pacific, the Western Union people, without even the shadow of a pretext in law, deliberately and secretly sent out 100 men to destroy the property of the Merchants' National company. About 75 miles of poles, wires and arms were dropped down and destroyed at different portions of the line, so as to wreck the entire property.

"Then the Western Union said to the Atlantic and Pacific, who owned the property, just as Dr. Green says now, 'You have your remedy in the courts.' Backed by the sharpest lawyers and with plenty of money, the Western Union knew that it was more than a match for its poorer and weaker competitor, and that they would be able to secure delay after delay before the case was tried until the Atlantic and Pacific people were tired out. This proved to be the case. The Atlantic and Pacific company could not fight the Western Union."

The daily press has been quite pronounced in its opinions of the raid. The following extracts will show the editorial views of different journals. The *Times* says:

The raid of the Western Union Telegraph Co. upon wires which did not belong to it was but another step in its struggle to maintain a monopoly over the telegraph system of this country. It was characterized by its usual methods of lawless disregard for the rights and interests of others and of the public, sustained by a sympathizing judge of the bench of the Supreme Court. The case is a plain one and no inside knowledge is needed for its perfect understanding.

* * * * * * * *

The plan was carried out in direct opposition to the interests and the wishes of nearly all those who had a stake in the property of the rival lines, and in utter disregard of the rights and interest of the public, because all the power and discretion of a judge of the Supreme Court was at the service of the monopoly. Anything like a judicial attitude or a desire to secure all the rights and equities involved would have suggested a more deliberate course, a full hearing in behalf of all concerned, and final action that would have had some regard for sound public policy as well as the rights of all parties to the controversy. But the end is not yet. Unless our judiciary is to be utterly discredited, steps will be taken to restore all parties to the legal position which they held before the forcible seizure of the wires was made, and lead to a fair determination of the rights of the bondholders of the two companies which the Western Union monopoly is trying to extinguish.

The *World*, under the head of "The Telegraph Anaconda," says:

There are two or three points in this last feat of deglutition which demand legal investigation, not only of a civil character but of a punitive character as well. Gen. Harland was appointed receiver of the American Rapid company by Judge Shipman. If he can be allowed to turn over his power as receiver to the Western Union company, that corporation was practically appointed receiver. Was it known to Judge Shipman that this was to be done when Harland was appointed?

Judge Donohue's extreme friendliness to Mr. Jay Gould's corporation needs explanation. Does Judge Donohue think it an honest judicial act to grant an order sufficiently broad to empower the Western Union corporation to seize not only the property of the Rapid but of the Bankers and Merchants' telegraph lines in the night time by the act of a band of marauders without giving the owners of the latter any notice?

It is time the people should be effectually protected against the telegraph anaconda. Its object in swallowing rival after rival is simply to rob the public by exacting high rates for telegraphic service. It had a double incentive now to seize the Bankers and Merchants' line by any high-handed outrage. If it can absorb every land line in the United States it will break down the "independent" or Mackay European Cable, which cannot long struggle on without land lines in the United States. And the Western Union and Anglo-American Cable company's interests are identical.

The *Herald* takes the ground that the raid was a violation of the law, as quoted above, and says:

The act of the Western Union in cutting and seizing the wires of the American Rapid and the Bankers and Merchants' was without warrant of law. The extraordinary ex-parte order of Judge Donohue did not give the color of legal authority for the depredation. That order directed Receiver Farnsworth to turn over the property of the American Rapid. The receiver said it was impracticable to obey it. The only lawful course then open to the Western Union was to go to the Court again. It had in Judge Donohue's order no authority or pretext to cut and seize the wires of the American Rapid by force against the protest of the receiver in possession, much less the lines of the Bankers and Merchants', whose transfer was not directed or contemplated by the order.

Besides being an offence against the criminal law, the act was a contempt of Court, punishable by imprisonment. A receiver is an officer of the Court which appoints him. He acts as the representative of the Court. He has been called "the hand of the Court." Property in his possession is in the custody and under the protection of the Court. Any unwarranted seizure of such property, any unlawful interference with it, is an offence against the Court. The Court is clothed with the power to punish the offender, and it is its duty to exercise that power. It is bound to do so to maintain its own authority, and the majesty of the law.

These principles are well settled and recognized. The United States Supreme Court thus gave expression to them in a recent case:—"A receiver is a representative of the Court. Property in his hands is in *custodia legis*. The Court will not permit his possession to be disturbed by force nor violence, to be offered to his person while in the discharge of his official duties. In such cases the Court will vindicate its authority and if need be will punish the offender by fine and imprisonment for contempt."

This power has been repeatedly exercised. It was exercised in the case of the recent strike on the Gould roads in Missouri.

The chaotic condition of the whole affair, caused by the numerous and conflicting interests involved, which are to be fought out in the courts, was a golden opportunity for the legal fraternity, and a most formidable array of lawyers appeared at the Supreme Court on July 14th.

Col. Robert G. Ingersoll appeared as counsel for the holders of the certificates issued by the receivers of the Bankers and Merchants' Telegraph Co., and asked for an adjournment of the hearing of the motions in the litigation to which the Bankers and Merchants' Telegraph Co. and its Receiver, Gen. Farnsworth; the American Rapid Telegraph Co. and its Receiver, Gen. Harland; the Western Union Telegraph Co., and the Farmer's Loan and Trust Co., as trustee of the ten-million dollar mortgage on the Bankers and Merchants' property are parties. The motions were, first, for the vacation of the order made by Judge Donohue on Friday directing the receiver of the Bankers and Merchants' to turn over to the Western Union, as the agent of Receiver Harland, all the property of the American Rapid company in his (Receiver Farnsworth's) possession under which Gen. Eckert, of the Western Union company, made his raid on the Bankers and Merchants' office and property; second, for the vacation of the injunction restraining the receiver of the Bankers and Merchants' from repossessing himself of the property taken from him by the Western Union people; third, for the opening of the decree obtained by the Farmers' Loan and Trust Co. on behalf of bondholders, foreclosing the ten-million dollar mortgage of the Bankers and Merchants' company; fourth, for the removal of the Farmers' Loan and Trust Co. from the position of trustee of that mortgage.

With Col. Ingersoll appeared Messrs. Edward Lauterbach, Charles Da Costa, Edward Guthrie, Francis L. Stetson, and Joseph Fettretch, as counsel for the parties directly interested in the Bankers and Merchants' company. Messrs. Turner and McClure represented the Farmers' Loan and Trust. The Western Union was represented by ex-judge John F. Dillon, Aaron J. Vanderpoel, and M. A. Eggleston. William G. Wilson championed the right of Receiver Harland to convey the American Rapid property to the Western Union, and Joseph Auerbach stood up for the bondholder, Powers, who objects to the foreclosure of the Bankers and Merchants' mortgage, and who desires the removal of the Farmers' Loan and Trust Co. from its trusteeship. It took a long time to have all these appearances noted, and to have it determined that all the motions should be heard at one time. Finally, Col. Ingersoll arose and informed Judge Donohue that he wished an adjournment. He said:

"The order made by Judge Shipman, of the United States Circuit Court, at Hartford, allowed his Receiver, Gen. Harland, to make such contract as he saw fit with any other person or corporation for the possession of the property of the American Rapid Telegraph Co. I have been informed that this court, acting under the order made by Judge Shipman—because that order was made—instructed its Receiver, Gen. Farnsworth, to deliver over to the agent (the Western Union) of that Receiver (Gen. Harland) the property of the American Rapid company; that afterward the agent proceeded to take possession of what they called the American Rapid company. There is, I believe a decree for the sale of the property of the Bankers and Merchants' company. The Western Union company, pretending to act under the order of Judge Shipman, not only took possession of the property of the American Rapid, but also of property of the Bankers and Merchants'—cut hundreds of wires belonging to the latter company, paid for with its money, strung on poles belonging to it—wires and poles never claimed by the American Rapid excepting through this agent. Now, the question arises, Would it be proper to sell the Bankers and Merchants' property under these conditions?"

"I entirely agree with you that it would not," said Judge Donohue.

"Would it be proper to sell this property, partly in the hands of enemies?"

"I have taken that to be so from the start," interjected Judge Donohue.

"Nobody would want to purchase a lawsuit at auction," continued the advocate. "You can get lawsuits at private sale. I move that these motions be adjourned unill Judge Shipman has had an opportunity of approving or disapproving of what has been done under color of his order. We say that his order has been violated, that an outrage has been committed, and that a certain wolf pretends to have an order from a shepherd."

No objection was made to an adjournment, although several of the counsel said they were ready to go on. In granting the

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motion, Judge Donohue said he had put the Bankers and Merchants' company into the hands of receivers last September, appointing receivers who were selected not by him, but by the parties in interest. From time to time it had appeared to him that the company was run at a great loss daily, and it had been his impression that its affairs ought not to be kept open. But the parties in interest had chosen to keep them open, and he had not felt that, under the circumstances, he should interfere. And now his failure to interfere was made the source of strictures. He had been convinced that the decree of foreclosure protected nobody, but as everybody consented to its being entered he signed it. He suggested that the results of past slovenliness should be inquired into in the light of present criticism, and that, before the hearing of the motions, the neccessary amendments should be made to the decree. He then appointed July 21 as the adjourned return day, and ordered all proceedings to be stayed meanwhile.

On July 16th the United States Court at Hartford, Conn., became the centre of interest in connection with the difficulties. Arguments were heard on a motion in the interests of the Bankers and Merchants' Telegraph Co., for an order to regain possession of its own lines, or wires strung on the poles of the American Rapid company, until the question of approving the contract made by Receiver Harland with the Western Union company shall be finally acted upon. An affidavit of F. W. Jones, general manager of the Bankers and Merchants' company showed that the wires claimed exclusively by the Bankers and Merchants' company could be readily identified. It was contended by counsel for the company that a contract was made by it with the Rapid Telegraph company in October, 1883, under which its property was kept distinct. By this agreement each company was to pay the other a given sum per mile of wire for the use of wire and poles owned by each.

Ex-Judge Dillon, counsel for the Western Union, said he was ignorant of the existence of any such contract and that it was not on record, but Mr. Ingersoll showed that it had been read at a former hearing. The latter's closing argument for the Bankers and Merchants' was to the effect that nothing unfair was asked, but only this—that the Bankers and Merchants' might have the use of its own property until judicial proceedings deprived it of it: that this use would not deprive the Western Union of any of its rights nor interfere with the use of the wires of the Rapid company. He said the court could not afford to permit, under the sanction of its own authority, such a violent construction of the contract entered into by its receiver as the use of an axe to cut wires on the very day the contract was entered into between the receiver and the Western Union company.

Judge Shipman at the close of the arguments spoke in support of the receiver's acts as being open and above board. It must be admitted, he said, that the allegation that the wires of the Bankers and Merchants' could be identified has been made for the first time to-day. It was impossible for him to determine by affidavits presented by one side only whether the wires designated were the property of the Bankers and Merchants' or not. The location of the wires has hitherto been unknown and indistinct to the receiver. It was right, he thought, that pending the action of the Court upon the contract the wires in dispute should be in the use and control of the Bankers and Merchants'. This is a side issue, which ought to be taken out of the main issue, and he would order that the receiver should be tendered the use of these wires subject to the order of the Court upon the confirmation of the contract with the Western Union.

The Court held a session during the evening, expecting that counsel would be able to agree upon the form of order to be issued. But an agreement was not reached, though the differences, relating mainly to descriptions of property, were slight.

Judge Shipman had previously announced his disqualification to try the main question as to the approval of the contract made by the receiver with the Western Union company. He is a small shareholder in the American Telegraph and Cable Co., which is leased by the Western Union, and he holds the relation to be that of landlord and tenant, as defined by Connecticut laws, and while there is no Federal statute to interfere, and the state law is not obligatory upon him, yet he says that the latter should be respected and that he is morally bound by it.

The following day he signed the order for the restoration of the telegraph lines claimed by the Bankers and Merchants' to that company. Gen. Harland, receiver of the American Rapid Telegraph Co., the Western Union company and the officers, agents, attorneys and employés of the same are instructed to see that this is done. Furthermore they are directed not to interfere with or hinder the operation, use and enjoyment of the lines.

The property held by the Western Union which is ordered to be returned to the Bankers and Merchants' is divided into three classes: 1, Bankers and Merchants' wires on Rapid poles; 2, Bankers and Merchants' poles on which Rapid wires are also strung; 3, Bankers and Merchants' wires on Rapid poles in New York city.

Under the order of Judge Shipman, the Western Union Telegraph Co., as the agent of the Rapid company, July 18, began turning back to the Bankers and Merchant's company such wires as the order called for. The wires are situated between Cleveland and Boston, and aggregate 6,000 miles in all, and are all on the poles of the American Rapid company, with the exception of a few hundred miles.

Under the order the Bankers and Merchants' company is required to turn over to the Western Union company all the wires of the American Rapid company now in its possession between Cleveland and Chicago and from Pittsburg to Indianapolis, via Cincinnati, and the loops to the oil centres, in all 6,150 miles, being about the same mileage as turned back to the Bankers and Merchants' in the East. This, the Western Union says in effect, cuts off the Bankers and Merchants' company from any connection west of Cleveland on the northern circuits and west of Cincinnati on the southern, and from connection with most of the oil cities.

In addition the Bankers and Merchants' is required to turn over all the instruments, switches, offices, tables, &c., in its possession belonging to the American Rapid company. The Rapid company claims that while the mileage of wire to be turned over to each company by the order is about equal that to be turned over to it in the East, it is by far the most valuable for business purposes, and includes 700 miles of poles.

Judge Donohue in Supreme Court, Chambers, New York on July 24, denied the motions to set aside the decree of foreclosure in the suit of the Farmers' Loan and Trust Co. for the forecloseure of the $10,000,000 mortgage upon the property of the latter company, in which a decree was entered authorizing the sale of the property, and for the removal of the Trust company from its position as trustee of the mortgage. The decree in the foreclosure suit was entered upon consent of all parties to it. Judge Donohue says that there are many defects in the decree, and the specific property sought to be covered by it, he says, can nowhere be found in the decree. Therefore, when the referee comes to sell the property, it will be somewhat difficult to tell what he sells and where he gets the power to sell any definite property. But the Court agrees with the Trust company that the applicant who represents $250,000 of bonds has no right at this time to intervene as a party to the suit, and for that reason the motion must be denied. He disagrees, however, upon the point that the objections are matters addressing themselves to the purchaser. He says:

> In my judgment this goes to the title of the property, and all dealings with it take with it full notice of the defects, and it seems to me buy with it, as one of the counsel for the bondholders remarked "a crop of lawsuits;" but on this application of the moving party I cannot interfere. On the motion for removal, I do not consider the merits at all, as a large mass of the bondholders now appearing are satisfied with the trustee. The Court fully agrees with the plaintiff on the propriety of an early sale, and pointed out the necessity long since of such a course, but I do not agree with them on either the necessity or propriety of what may be selling what may prove a defective title.

THE BALTIMORE AND OHIO COMPANY BURNED OUT.

At 7:40 P. M. July 4th, smoke was seen to issue from the basement of the building 63 Broadway. Policeman Wm. Clark sent out an alarm from the corner of Rector street.

Engine Company No. 6 was the first to appear on the scene, and as the men pulled up at Trinity place and Rector street flames were pouring out of the rear, and a second alarm was sent out. The blaze then broke out of the windows of the operating room on the Broadway side, and as it was known that there were a number of operators in the room much uneasiness was felt as to their safety. But when the firemen got up there they found the rooms deserted. When the smoke first reached the top of the building there were about twenty operators in the room. The fire increased so suddenly, and the volumes of smoke became so dense that they were afraid to attempt to gain the street by the stairs. A ladder which runs to the cupola, where the wires enter, enabled them to reach the roof. They then reached the street through the American Express Company's building, which adjoins. They had hardly left their places when the room was in flames.

A third alarm was sent out, and shortly afterward special alarms summoned four more engines. On the Broadway side the flames poured fiercely out of the fifth story windows. The offices of the American Express Company adjoining on the north, and those of the Adams Express Company on the south, seemed to be in peril. The breeze from the south caused the fire to lick both these buildings, but a strong stream was soon playing from the water tower and they were saved. After this there were two loud reports as if caused by explosions, and the flames gained new strength. But the stream from the water tower was well directed, and the flames began to dwindle. In the meantime the rear of the basement at No. 45 Trinity place was in flames, and the fire made rapid progress up the elevator. Another call was immediately sent out, but the combined forces were unable to subdue the fire until the immense stock of vitriol and telegraph instruments belonging to the Baltimore and Ohio company had been destroyed. On the ground floor was also a large stock of hides and vanilla beans, which were entirely destroyed.

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The fire burned rapidly on the Trinity place side of the building, and soon the whole structure was in flames, and long, fierce tongues of fire shot out into the street. Owing to the fact that the elevated road runs close to the buildings, the firemen were handicapped in their endeavors to successfully reach the upper windows, and it was only by working at one floor at a time that any results were accomplished. The hose was hauled up on the elevated tracks, and travel was delayed thereon for over two hours.

By desperate fighting the fire was confined to the basement, first floor and top story. When under partial control several firemen crawled along the cornice, which had been badly eaten out by the flames, and turned on a stream of water, but it was not until after two hours' hard fighting that all danger of the spreading had passed. Even towards the last the fire would regain new life and become dangerous.

The basement is used by the telegraph company for its messenger department and as a store-room. The fire originated in the rear.

In the basement were stored the battery supplies, and there was also a small restaurant, and a wardrobe containing messengers' uniforms.

Several boys who were on duty say that there were several firecrackers exploded during the day. One was heard to go off in the dark room, which was used for storing paper. So it is supposed that the boys let the cracker fall among the paper, and the fire probably slumbered for some time before breaking out.

Temporary quarters were secured for the operating room at 61 Broadway, the aerial cables led in, new supplies of instruments and battery secured, and on Monday morning facilities had been provided for the transmission of all business.

The loss to the telegraph company was about $10,000 on which there was no insurance. The executive offices are now located at 57 Broadway.

DECISION IN BURGLAR ALARM SUIT.

HOLMES ELECTRIC PROTECTIVE CO. *v.* METROPOLITAN BURGLAR ALARM CO.

U. S. Circuit Court, Southern District of New York.

Decided December 4, 1884.

1. It is only a patent for an invention that has been previously actually *patented* in a foreign country that is limited by the foreign patent.
2. The mere *description* of an invention in a foreign patent does not operate, under section 4887 of the Revised Statutes, to limit a domestic patent for such invention.

STATEMENT OF THE CASE.

This suit was brought for an infringement of Letters Patent No 120,874, granted Edwin Holmes and H. C. Roome, November 14, 1871. An injunction was granted, after argument, September 2, 1884. On November 22, 1884, the suit came up on motion of defendant to vacate the injunction. The ground of this motion was that the invention had been previously patented by the inventors in an English patent dated November 1, 1870, the 14 years' term of which expired November 1, 1884, and that by consequence the patent in suit expired at the same time.

Complainants opposed the motion on the ground that while the invention was *described* in the specification of the English patent, it was not "patented" therein within the meaning of section 25 of the Patent Act of 1870 or section 4887 of the Revised Statutes, the *claims* of the English patent not being for the invention set forth in the claims of the patent in suit and incidentally described in the specification of the English patent.

Mr. S. A. Duncan for the complainant.

Mr. F. W. Whitridge for the defendant.

WHEELER, *J.:*

The invention patented in the patent in suit, as the same was construed in granting the injunction now sought to be dissolved, was not patented in the English patent which has expired, the expiration of which is relied upon to terminate this patent, and is the ground of this motion.

It is only a patent for an invention that has been previously actually patented in a foreign country that is limited by the foreign patent. The description of the invention in the foreign patent might affect the validity of the domestic one, and might not, but would not limit it. (Rev. Stat., sec. 4887.)

The effect of the various patents was considered when the injunction was granted as bearing upon the validity and construction of this one, and those questions are not open upon this motion as made.

The motion is denied.

HEAVY JUDGMENT AGAINST THE WESTERN UNION.

Upon the report of Referee James C. Spencer, a judgment was entered, July 24, in the Superior Court against the Western Union Telegraph Co. and in favor of James H. Goodsell for $240,159.11. In January 1881, Mr. Goodsell, as president of the National Associated Press, made a contract with the Atlantic and Pacific Telegraph Co. for the dissemination of news. The contract went into effect on Feb. 1, 1881, but on Feb. 3 the Atlantic and Pacific company fell into the hands of the Western Union company, which assumed to carry out its contracts. The Western Union company in 1882 charged Mr. Goodsell greater rates, and stopped the service because he refused to pay them. In July, 1882, Mr. Goodsell brought suit against the Western Union company to recover $22-000, which, he alleged, the company had collected from different newspapers for his service and had failed to account to him for. He also asked for damages to the extent of $650,000 for a breach of contract. The Western Union company alleged that the contract was invalid and fraudulent, and that a new arrangement had been made and carried out, but that finally Mr. Goodsell abandoned the work. For this they put in a counter claim for $15,000 damages.

Of the judgment entered on the referee's report $220,306 is for damages and $16,777.42 for money due, the rest being interest.

OFFICIAL ETIQUETTE OF THE ASSOCIATED PRESS.

It is so rarely that the public is given an insight into the peculiar methods of the Associated Press that the following telegram should be of interest:

CHICAGO, July 15, 1885.

To D. H. BATES, *President of the Baltimore and Ohio Telegraph Co., New York:—*

In the New York papers of Monday which have reached here I find your card relative to the statement that the Baltimore and Ohio company had been trying to get the Western Union Telegraph Co. to take its wires. I regret that you made the reference you did to the Associated Press without first inquiring into the facts. As you have always had courteous treatment at our hands and have secured through the Associated Press publicity for your business on various occasions, this insinuation of suppression is ungenerous. There is an unwritten law in the office which forbids the denying of statements of that character unless made by some agent of the Associated Press. This law is to prevent unpleasant complications with the individual newspapers. The day manager of the New York office informs me that as your letter accused the *Post* of publishing a falsehood, he was restrained by the rule from giving out your letter to the New York papers. He did, however, supply the fact of denial to outside papers. If you had sent to us a general statement not involving a question with an individual newspaper it would have received just such attention as you wished in this case. This suggestion applies to the future as well as to this single instance.

You know that the Associated Press has no relations with the Western Union Telegraph Co. that stand in the way of extending to the Baltimore and Ohio company any courtesy or any business we choose. Hence we have no interest in suppressing anything that you wish to make public coming within our rules applicable to all. Let me hope that hereafter you will avoid any public statement conveying a different impression.

WILLIAM HENRY SMITH, General Manager.

ORGANIZING THE UNDERGROUND COMMISSION.

The underground wire commission, appointed under the laws of 1885, to compel the telegraph, telephone, and electric light companies to take down their poles and place their wires underground, held its first meeting for organization at the Metropolitan hotel, July 20. Mr. Hess called the meeting to order, and nominated for president Mr. Loew, who was unanimously elected. Mr. Moss was appointed secretary, and F. A. Lovcraft assistant secretary.

The commission having thus organized for business, president Loew offered a long preamble and resolution, declaring that under the law it was the duty of the commission to cause all telegraphic, telephonic and electric light wires to be put underground, and that the commission proposed to do the work for which it was appointed as speedily as possible. The law requires that plans and maps, with estimates of cost, shall be filed by the companies with the board within 60 days after its passage, or before Aug. 14, and if they do not do this the commission is authorized to adopt a plan of their own. It is the purpose of this board, the preamble says, to cause the wires to be placed underground, and the secretary is instructed to notify all persons or companies owning or controlling the wires above ground that the board will receive at the Metropolitan Hotel any plans, maps, or methods proposed for its approval; and that it requests that such plans be submitted as soon as practicable before the expiration of the 60 days prescribed in the law. The resolution was passed The following, proposed by Mr. Hess, was adopted.

Resolved, That the owners, lessees or occupants of houses be requested to refuse permission for the placing of any telegraphic, telephonic, or electric wires over or on their respective buildings, without first securing a permit from this board.

Another resolution, offered by Mr. Hess, requesting the companies to offer to the board at its next meeting any plans which they may have for placing new wires above ground, was passed, and the commission adjourned.

Mr. Moss said to a reporter, in reference to the work to be done: "We are thoroughly in earnest and intend to see that the Daly bill is executed. We don't believe in oppressing the companies, of course, but we shall do our whole duty under the law. The poles and wires must go, and if the companies do not present plans to us before Aug. 14 we shall certainly adopt a plan of our own and see that the wires are buried in accordance with it. The companies will have to spend some money at first, of course, but I believe in the end it will be money in their pockets. The commission, at all events, is thoroughly in earnest, and will do the work intrusted to it faithfully."

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BOSTON ELECTRIC LIGHT COMPANIES CONSOLIDATE.

After a year's negotiations the three electric light companies of Boston have determined upon combining their forces. They are the Brush Electric Co., the New England Weston Electric Co. and the Merchants' Electric Light and Power Co. The new combination will be known as the Union Electric Light and Power Co. of Boston, and is to be organized under the general laws of Massachusetts, with a capital stock of $700,000, the par value of the shares to be $100. The stock will be divided as follows : Brush company, $250,000; Merchants', $225,000, and Weston, $225,000. It is estimated that the plant of the three companies has cost $1,000,000. The Brush company has a debt of $91,000 and the Merchants' a debt of $47,000, while the Weston company is free from liabilities. The consolidated company will assume these debts and put the same in 15 year bonds. It is estimated that the real estate acquired by the combination will offset the debts.

THE STANDARD UNDERGROUND CABLE COMPANY.

The vast extent of the electrical systems in New York and Brooklyn, which are to be placed underground "wherever practicable," renders this an important field for the introduction of approved subterranean methods. To meet the anticipated demand, the Standard Underground Cable Co. has established at 128 Pearl street, in this city, an agency for the sale of the Waring lead-covered cables. Mr. George L. Wiley has assumed the management of the New York office. Mr. Wiley is thoroughly versed in the requirements of the electrical companies for city work. With fourteen years experience in the private line and telephone service as operator, chief operator, assistant superintendent, and superintendent with the Gold and Stock Telegraph Co., and Metropolitan Telephone and Telegraph Co., he will be found a competent adviser to all who propose to avail themselves of the advantages of the system which he now represents.

THE PITTSBURG TELEPHONE DECISION.

The Western Pennsylvania Telephone and Telegraph Co., about a year ago, entered into the telephone business at Pittsburg, Pa., as a licensee of the National Improved Telephone Co., of Louisiana, using instruments said to be based on the patents of C. A. Randall and J. Harris Rogers. An exchange system was built up, embracing over 300 subscribers. Suit was brought against the company by the American Bell Telephone and the Central District and Printing Telegraph companies for infringing the Bell patents. The defense was based mainly upon the anticipation of the Bell telephone by the Reis transmitter. The hearing was before Judge McKennan and District Judge Acteson. Counsel for the defense had barely started his argument, when he was stopped by Judge McKennan, who ordered a preliminary injunction. The business of the company is now at a standstill, and the instruments of the subscribers are being removed. No new points whatever were developed by the litigation.

THE USES OF PHOSPHOR-BRONZE.

The new catalogue issued by the Phosphor-bronze Smelting Co. of Philadelphia, will be found of interest to all who desire to know of the advantages possessed by this beautiful metal, for various mechanical purposes. For special electrical use it is manufactured into line-wire ranging from number 6 to 20, both bare and insulated ; cast-rods and wood-screws are also furnished for shop work.

TELEPHONIC LITIGATION IN CANADA.

In the case of the Bell Telephone Co. *vs.* Telephone Manufacturing Co., an action brought to cancel the Bell patent for not complying with certain regulations of the patent law, the Bell company last May made application for a writ of *certiorari* to remove all proceedings, evidence and papers from the Department of Agriculture into the Common Pleas Division, contending that the Minister of Agriculture had no authority to adjudicate upon the validity of the patent so attacked. A full court, on June 27th, decided otherwise, and dismissed the Bell motion with costs.

TABLE OF RESISTANCES OF PURE COPPER WIRE.

We have reprinted in our advertising pages this issue the valuable table of resistances calculated by George B. Prescott, Jr., which appeared in our June number. This will enable our readers to cut it out, without mutilating the magazine for binding. The copyright of this table has been assigned to Messrs. Holmes, Booth & Haydens, and its future publication has consequently passed into their hands.

ELECTRIC LIGHT AND POWER.

Domestic.

One hundred feet of the Hoosac tunnel will be arched with brick this summer, instead of 50, as in former years. The problem of lighting the tunnel has not been satisfactorily solved. It is said that electric lights are hardly practical, as they will not penetrate the smoke. Manager Locke thinks smoke-consuming engines will some time be constructed to pass through the tunnel, when it will be an easy matter to keep the tunnel sufficiently lighted.

The electric light-carriage, or "telpherage" system, is being experimented with in Philadelphia. Two cables are used, one above the other, the packages being suspended from the upper and steadied by the lower, and the cables serving as conductors.

The company recently organized at Westchester, Pa., for the purpose of furnishing electric light in the borough, have closed a contract for a plant of the Edison incandescent system, and the work of preparing a building for housing the same has been commenced. Some arc system for street lights will soon be settled upon by the same company, which has a capital of $30,000.

The Electric Railway and Power Co. have filed articles of association with the Secretary of State in Missouri; capital, $350,000. The company's board of directors is composed of the following named citizens of St. Louis: John W. Harrison, John Jackson, B. D. Lee, John N. Bofinger, Aug. Gehner, John W. Donaldson, Chas. Hoyle, T. S. McPheeters, R. D. Lancaster, Francis E. Nipher, Wellington Adams, Chas. Thaw, Edwin Harrison.

Eight electric arc lights have been placed in the Union baseball park, St. Louis, to enable athletic sports to be carried on at night.

The city council at Kansas City, Mo., has awarded the Local Electric Light Co. a contract for furnishing them with 25 Thomson-Houston arc lights. If these are satisfactory, the number will probably be increased.

The Bain Electric Co. of Chicago, are putting a plant of electric arc lights in the Bates House at Indianapolis, Ind., and a plant of incandescent lights at Menasha, Wis.

The Reading, Pa., Electric Light Co. have made arrangements by which they can furnish from one to 100-light dynamos to persons who may want to run their own lamps.

Foreign.

During the past six years dynamos to the number of 6,000 have been constructed in the different workshops in Germany, representing a value of $3,500,000. The number of arc lamps made during the same period was 20,000, realizing $1,250,000.

Six British gunboats are to be supplied immediately with dynamo-electric machines and engines for working the electric light, and every effort is to be made to bring the equipment up to the most advanced stage of the art of electric naval illumination.

Consul Stevens writes from Victoria, B. C., that the electric light and telephone systems prevail, but the city has no sewerage, and the sidewalks are of wood.

An electric railway is about to be constructed between the village of Saint-Maurice and Pontresina. The motive power will be derived from the waterfall of L'Inn, which will also be utilized to supply the force necessary in the electric lighting of the village. It has been specially stipulated that the new railway shall not in the slightest degree detract from the beauty of the neighborhood.

Mr. Reckenzaun has produced designs for a torpedo-service launch, to be propelled at high speed by electricity. The conditions enjoined are that this craft should make a voyage across the English Channel and back in moderately fair weather. It is confidently believed that the test can be complied with, and the construction of the vessel and machinery is to be commenced without delay. In view of important improvements in the electrical appliances her speed may be expected to exceed anything hitherto attempted.

MANUFACTURING AND TRADE NOTES.

The cable manufacturing business established by Samuel C. Bishop, and for many years known as the Bishop Gutta-percha Works, has been transferred to the newly formed Bishop Gutta-percha Co., of which Samuel Boardman is agent. Mr. W. W. Marks will still continue the superintendent. This is the only establishment in the country devoted to the manufacture of gutta-percha insulated wire and cables.

The Brown Electric Co. are preparing to occupy their new quarters, 1, 3 and 5 Michigan street, Chicago. In these works they are putting some very fine machinery. They are also fitting up a laboratory with complete appliances.

The Western Electric Co. at Chicago, has recently put into operation at Mansfield, O., an electric light plant, and has placed

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50 lights in Dickinson's bazaar, St. Paul, Minn. It is turning out large quantities of cable and sending to the Bell Telephone Co. at Pittsburg 195 miles of conductors, An order for five miles of conductors has been sent to Washington, D. C. The company is making a multiple switch-board for shipment to Antwerp, Belgium.

MISCELLANEOUS.

The Electric Protection Co. has been organized in Philadelphia with a capital of $50,000. The officers are as follows: President, Charles M. Swain; secretary, Wm. Carley; treasurer, Geo. B. Dresher; directors, Chas. M. Swain, Chas. D. Freeman, Wm. P. Wheatland, R. Lloyd Lee and Harrison Stiles.

The Electric Aurophone Co. has recently been incorporated in St. Louis, with a paid up capital of $50,000, for the manufacture and sale of Ehrlich's electrical device for the improvement of hearing. The officers are: J. A. Parker, C. C. Nicholls, and E. V. M. Powell, president, vice-president and secretary, respectively.

The Secretary of State of Illinois has licensed the American Burglar and Fire Alarm Co.; capital stock, $30,000; incorporators: Robert Wiseman, Charles W. McClellan, and D. L. Foote.

PERSONAL MENTION.

Charles Williams, Jr., one of the oldest electrical instrument manufacturers in the country, is about to retire from business. The Boston factory, which has been devoted to the manufacture of telephones for the past six or seven years, is to be closed and the work transferred to the New York and Chicago factories of the Western Electric Co. Mr. Williams was among the early and fortunate pioneers in the telephone industry, and is believed to be well prepared to enjoy his release from the care and responsibility necessarily attendant upon the management of a large manufacturing establishment.

Henry W. Pope and wife sailed for Europe, July 16th, on the steamer *State of Alabama*, for a two months' trip. They arrived safely at Glasgow on the 27th ult., after a pleasant passage.

THE TELEGRAPH.

A Texas paper reports that the corn-stalks in that state are so tall and large that they are being used as telegraph poles by the Baltimore and Ohio company.

The Pennsylvania Railroad Co. has introduced a new and very accommodating feature on the limited trains. The conductor on each of these trains is supplied with a large package of envelopes, each of which is weighted with lead, so that they may be tossed from a moving train to the station agent by passengers who wish to forward telegrams before the train reaches its next stopping place. On the envelope are printed directions for the telegraph operator to forward the despatch at once.

In the case of the city of New Orleans against the Western Union Telegraph Co. to recover $3,060 on an ordinance which provides that no telegraph poles shall be allowed to be erected in certain portions of the city except upon payment of $5 per annum for each pole, a decision has been rendered in the United States Court allowing judgment to the full amount against the telegraph company.

The Empire and Bay States Telegraph Co. has been incorporated by a certificate filed in the New York County Clerk's office. Its capital is $250,000, but may be increased to $10,000,000. Its lines are to run from this city to the east and south and along the Atlantic coast generally. The incorporators of the company are Andrew J. Baldwin, John Henry Miller, and Charles J. Marsh. The first named two hold 1,000 shares each, and Mr. Marsh 500.

The Atlantic Telegraph Co., incorporated under the Maine and New Hampshire laws, with a capital of $100,000, has been organized. The new company, which is owned by Boston and New York capitalists, will not extend its wires beyond New England. While it has been started purely as a local institution, an important alliance has been entered upon with the Baltimore and Ohio company. The officers are as follows: president, John W. Deering; treasurer, John J. Donovan; superintendent, Edward A. Leslie.

At a meeting of the incorporators of the Pacific Telegraph Co., held in Wyandotte, Kas., the following officers were chosen: E. L. Martin, of Kansas City, president and treasurer; E. S. Stokes, of New York, vice-president; George M. Meyers, of Kansas City, secretary; L. D. Parker, of Chicago, auditor. The capital stock of the company is $300,000. The majority of the stock has been subscribed in Kansas City and Omaha.

THE TELEPHONE.

The telephone subscribers of Evansville, Ind., in convention assembled, have resolved to pay no more than $3 per month for their telephones. The Indianapolis subscribers had previously made a similar decision.

Suit was entered in the United States Court at Memphis on the 10th inst., by the Pan Electric Telephone Co. against the American Bell Telephone Co. The bill filed charges that the Bell company's patents interfere with the Pan Electric patents, and are, to that extent, void; that the Bell company has slandered and misrepresented the patents and inventions of its opponents; that the Bell telephone in use is not the one described in its original patent, which is used only to litigate with; that Bell was not the first and original inventor of the art, it being known to, and described by Philipp Reis, of Germany, who died in 1874.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From June 16th, to June 30th, 1885 (inclusive).

Alarms and Signals:—*Transmitter*, J. C. Wilson, 320,032, June 16. *Push-button*, John Geary, 320,238. *Burglar Alarm*, A. Jacobi, 320,660, June 23. *Bell*, H. B. Porter, 320,685. *Call Instrument*, F. B. Wood, 321,073, June 30. *Method of Producing Responding Signals*, A. G. Holcombe. 321,110.

Clocks:—F. Bauman, 320,997, June 30.

Commutators:—*Switch*, E. C. Titus, 320,019, June 16. *Circuit-breaker*, E. Weston, 320,028. *Circuit-closer*, J. E. Root, 320,504, June 23.

Conductors, Insulators, Supports and Systems:—*Conduit*, Charles G. Perkins, 319,998, June 16. *Cable*, P. B. Delany, 320,229. *Conduit and Discharger*, E. H. Hoffman, 320,253. *Conductor*, Leo Daft, 320,632, June 23. *Insulating Pipe Union*, C. H. Fischer, 320,645. *Method of Making Conductors*, W. S. Platt, 320,684. *Insulating Compound*, R. S. Ferguson, W. Schumacher and W. Tubman, 320,921. June 30. *Joint for Cables*, W. R. Patterson, 321,240. *Means for Driving Conductors into Conduits*, D. N. Hurlbut, 321,363.

Dynamo Machines and Motors:—*Engine*, C. A. Jackson, 320,137, June 16. *Core for Armatures of Dynamos*, J. H. Muller, 320,158. *Dynamo*, J. M. Rivera, 320,170. *Regulator for*, M. G. Farmer, 320,234. C. L. Buckingham, 320,840, 320,842, June 23. *Armature for*, A. H. Bowman, 320,754. *Reciprocating Engine*, C. J. Van Depoele, 320,515. *Motor*, J. M. Pendleton, 321,049, June 30, Frank J. Sprague, 321,147, 321,148, 321,150.

Electrolysis.—*Process of Depositing Nickel*, J. G. Mathieu, 320,577, June 16.

Galvanic Battery:—Otto Fleming, 320,547, June 23.

Ignition:—*Gas Lighter*, C. A. Hussey, 320,065, June 16. *Turning on, lighting, and shutting off Gas*, L. S White, 320,105, 320,106. *Gas Lighter*, same, 320,-606, June 23. *Igniter for Gas-Engines*, D. S. Regan, 320,285, June 16.

Lamps and Appurtenances:—*Arc lamp*, E. Thompson, 320,018, June 16. G. Pfannuche, 320,585, June 23. C. L. Buckingham, 320,841, 320,848. *Holder for Incandescent Lamp*, E. Weston, 320,026. 320,027, 320,029, 320,030, June 16. *Socket and Switch*, D H. Cunningham, 320,117. *Manufacture of Filaments*, F. Schaefer. 320,297. *Incandescent Lamp*, John A. Yunck and John Stuertz, 320,739, June 23. *Moulds for making Incandescents*, O. A. Moses, 321,309, June 30.

Measurement:—*Rheostat*, J. Doyle, 321,285, June 30.

Miscellaneous:—*Device for Preventing False Alarms*, 320,068, June 16. *Sight for Fire-arms*, W. Winans, 320,200. *Process for Setting Type*, J. E. Munson, 320,271. *Type-setting Machine*, same, 320,272. *Device to Enable Showmen to Walk on Ceiling*, N. H. Clyde and W. Berrigan, 320,275. *Machine for Dressing Carbons*, W. J. Possons, 320,497. June 23. *Game Indicator for Pool-tables*, 320,542. *Lock*, C. Blattmann, 320,617. *Induction Coil*, W. Stanley Jr., 320,717. *Mariner's Compass*. R. L. Sleater, 320,823. *Mechanical Movement*, S. Tideman, 321,062, June 30. *Registering Apparatus*, 321,069. *Exercising Machine*, G. P. Clark and G. Harsin, 321,278. *Combined Weighing Scale, Flour and Bran Packer*, C. W. Roth, 321,387.

Protectors:—*Cut-out for Circuits*, E. Thomson and E. W. Rice, 320,017, June 16. *Protector for Instruments*, D. J. Cartwright, 320,912, June 30, W. F. C. M. McCarty, 321,235.

Railways and Appliances:—*Tramway*, C. Basto, 319,947, June 16. *Locomotive*, J. Weis, 320,025. *Car*, A. Reckenzaun, 320,092. *Railway System*, F. L. Pope, 320,283. F. J. Sprague, 321,141, June 30. *Train Signal*, M. F. Parrish and S. J. Munn, 320,495, June 23. *Switch*, L. Daft, 320,630. *Track Insulator*, same, 320,631, 320,633. *Railway*, W. Painter, 320,679.

Storage Battery:—J. DuShane, 320,232, June 16.

Telegraphs:—*Repeater for Quadruplex*, T. R. Taltavall, 320,311, June 16. *Type Wheel for Printing Instrument*, C. A. Mathiesen, 320,376. *Escapement for Printing Instrument*, Geo. B. Scott, 320,975, June 30. *Fire and Police Telegraph*, C. Selden, 321,058.

Telephone Systems and Apparatus:—*Mechanical Telephone*, H. and E. Seligmann, 320,181, June 16. J. R., J. D., and C. F. Holcomb, June 30. *Circuit*, H. S. Thornberry, 320,414. *Support*, T. W. Lane, 320,438. *Individual Signaling Apparatus*, E. F. Frost, 320,923, June 30. *Method of and Means for Preventing Interference in Combined Telegraphic and Telephonic Systems*, F. Van Rysselberghe, 320,987, 321,404. *Transmitter*, H. S. Thornberry, 321,323. *Duplicate Switch-board System*, C. E. Scribner, 321,390. *Multiple Switch-board*, same, 321,391.

Expired Patents.—A list of the more important electrical patents which expired during the month of July, 1885, together with those which will expire during the current month is subjoined:—A. C. Garratt, *Battery*, 79,567, July 7.—Edmands and Hamblet, *Dial Telegraph*, 79 741, July 7.—Biggar & Blood, *Burglar Alarm Circuit-Breaker*, 79,894, July 14.—Biggar, Blood & Griswold, *Burglar Alarm*, 79,895, July 14.—Bishop & Marks, *Machinery for Coating Telegraph Wire with Gutta Percha*, 79,896, July 14.—G. Natcher, *Railway Alarm Signal*, 79,915, July 14.—A. H. Castle, *Line Insulator*. 79,951, July 14.—J. H. Guest, *Thermostat and Alarm*, 79,972, July 14.—Same, *Burglar and Fire Alarm*, 79,973, July 14.—W. B. Allyn, *Mechanical Morse Transmitter*, 80,-049, July 21.—G. Little, *Telegraphic Recording Instrument* (*floating pen*) 80,293, July 28.—M. G. Crane, *Gong-Striker for Fire-alarm Telegraph*, 80,-822, August 11.—M. G. Farmer, *Duplex Telegraphy*, 81,485, August 25.

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THE ELECTRICIAN AND ELECTRICAL ENGINEER.

Conducted by F. L. POPE. R. W. POPE, Associate Editor.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

NEW YORK, SEPTEMBER, 1885.

THE ELECTRIC LIGHT CONVENTION.

NOTHING can be more beneficial to the wholesome growth of a new business than an occasional assemblage of its practical workers, to learn from the experience of each other such facts as will prove advantageous to the whole body. Even the man who knows it all is benefited, for he is thus stimulated to renewed exertions by witnessing the earnest manner in which active, intelligent men are continually seeking for more light. Although two of the largest electric lighting companies were conspicuous by their absence, it is to be hoped they will eventually enter the ranks, and do their share toward establishing harmony between the various interests. Having personally watched the proceedings continually during the sitting in this city, we must confess our surprise at the thorough and impartial manner in which the rival interests were guided through the intricacies of debate on various subjects, without at any time giving a clue to the opinions of the members as to the merits of the different systems which they might represent. Those who did not understand this to be the case must have learned it before they went away.

The policy of the convention was defined by the sharpest possible line. A member was operating an electric light plant. He burned a certain amount of fuel; where was the fault, if any? Another ran his dynamos direct from small engines, while under similar circumstances in a different city a large engine with lines of shafting was used. Advice might be given to throw an engine into the scrap-heap, but the dynamo was not criticised. Those who seek to advertise their wares in a place of this kind must be very certain that they contain no flaws. It was a convention devoted primarily to the interests of those who produce and sell electric light, and the problem which is constantly before these gentlemen, whether at home or abroad, is the same which ever serves as the mainspring of progress: How can we secure the greatest return with the least expenditure. As a delegate expressed it, after adjournment, in conversation with a friend, "I do not care whether I supply the Brush, the Weston, or any other lamp, but what I do want is what I consider the best, and if I cannot get it from one maker I will from another."

It is frequently the case in a convention of this description, where members have come from a distance and at considerable expense and inconvenience, the question is asked, "What are we here for?" This would have been superfluous here, for it was apparent at every stage of the proceedings that all else was secondary to the interests of the active members.

It is plainly evident, however, that practical arc lighting is more closely allied to mechanical than to electrical engineering, or rather that economy in the operation of arc light plants is sought within the domain of engine, boiler, furnace or shafting rather than in the construction of the dynamo or the principle of the lamps. It is of more importance that the fireman should understand the principles of producing steam than that the electrician should understand the principles by which the dynamo produces a current. A dynamo is simply a machine that is driven at a certain speed, and produces certain results under fixed conditions. The steam boiler and the furnace will only produce certain results when carefully attended, as the conditions are continually fluctuating. The successful manager of an arc light plant is he who by practice and association becomes the most skilled in mechanical engineering. If such be the case the respective merits of the various dynamos are of less importance than the distance between the boiler and the grate, the quality of coal, or the skill of the fireman. The attention of dynamo inventors who seek to increase the efficiency of the machine is respectfully directed to the above thoughts, developed at an electric light convention.

ELECTRIC RAILWAYS IN PRACTICE.

CONSIDERABLE skepticism still exists as to the successful application of electricity to the propulsion of railway cars. There is a substantial reason for this, as it has been far easier to demonstrate on paper its advantages for this service than to actually introduce it as a substitute for direct acting steam or horse power. Admitting that such advantages exist, there are still sufficient differences of opinion as to the merits of various systems to account for the apparent delay in permanently adopting any of them. A thorough equipment of this character is not only originally expensive, but when once laid down it should remain, and for this reason, if no other, the best should be secured. There are no doubt many people who believe that the only preparation essential is to provide the required conductors, place a motor on a car, belt it to the axle, establish a dynamo plant at a convenient station, make the necessary connections, and "let her go." That might be putting matter in motion, but it would not necessarily constitute an efficient railway service; and taking the New York elevated railroads as a criterion, the supplanting of the present operating system is no child's play. A motor which is perfect in every other respect, but is given to

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occasional fits of jumping the track, will not do, no matter how economical its operation may be. In the light of past experience it appears somewhat doubtful if a line already taxed to its fullest carrying capacity is the proper place to demonstrate the feasibility of an experimental system, not because it is unequal to the work, but simply for the reason that minor defects in such cases lead to serious results. Fifty years of steam locomotion have been necessary to the development of the modern railway. To suppose that this accumulated experience is to be heedlessly brushed aside, and that the electrical engineer, trained in another school, is to immediately provide a satisfactory substitute is the height of absurdity.

The popular idea of a railway operated by steam is a track, made up of iron or steel rails, over which trains of cars are hauled by locomotives. This is the final outcome of practical experience.

The electric railway, which has barely emerged from the guidance of its numerous inventors and exploiters, already exists in various forms, all of them being more or less crude. There is the overhead, the side, and the subterranean conductor, in all of which the current is derived direct from a dynamo; then there is the self-contained principle in which the current is supplied by a storage battery carried on the car. The latter system is intended more especially as a substitute for horse-cars. One inventor merely substitutes an electric for a steam locomotive, with its train of cars to haul, while another makes a motor of each car. Furthermore, no inventor appears to entertain proper respect for the systems advocated by his rivals.

One of the greatest drawbacks to a new branch of electrical industry, looking from a financial standpoint, is the continual march of improvement, forcing upon the management not only the adoption of new devices, but the actual abandonment of the apparatus which is superseded. This has been the experience in both the telephone and electric lighting fields, and there is no reason for believing that the electric railway will be an exception, especially as there is already a wide divergence in opinion as to the most desirable plan. While we have perfect confidence in the future availability of electricity as an economical method of applying power, it must be intelligently used. Its advantages can and will be demonstrated, and the various practical tests which are now being carried on in this country as well as Europe will eventually be crowned with complete success.

THE INCANDESCENT BRANCH OF ELECTRIC LIGHTING.

It is very probable that among those present at the recent meeting of the National Electric Light Association, there were a few who had not given proper consideration to the fact, that the arc lamp cannot be expected to supply more than from three to five per cent. of the artificial illumination of towns and cities. Its field is confined to street lighting, and in-door use in large sales-rooms, foundries, factories, and for such similar localities as experience has already shown it to be peculiarly adapted for. Statistics have also demonstrated the fact that the consumption of gas has actually increased where the electric light has been introduced.

The future extension of electric lighting must depend largely upon the success of the incandescent lamp, which has been comparatively neglected by those who have placed the arc system upon a paying basis. It has already been demonstrated in several instances that it is not necessary to underbid the existing price of gas in order to obtain a market for incandescent lighting. Its acknowledged superiority is so generally recognized that it commands a higher price, as is the case with numerous other commercial products.

There appears to be no substantial reason why the owners of existing plants now used solely for arc lighting should not undertake, cautiously perhaps, the gradual introduction of incandescent lighting, based upon the well understood commercial principle of demanding a fair profit. To do this properly will require more careful attention to the economical distribution of electricity, and success will depend in a great measure upon the skill and intelligence with which the system is arranged, and no doubt the same scientific supervision would in many cases lead to better results than have already been attained with arc lamps. Continued prosperity depends upon the occupation of new territory, as well as the active cultivation of that which has already been covered. It will very likely be found that towns which do not afford a lucrative field for arc lighting alone, may do so in combination with an incandescent system, provided of course that the population is largely composed of a class who not only appreciate its numerous advantages, but are able and willing to pay for them.

To those who are so situated that they can do so, we offer the suggestion that they fit up their offices with such incandescent lamps as they choose to adopt, mounted on those elegant fixtures which are now provided for that purpose. Let them satisfy themselves by actual experience as to the cost and desirability of extending their use. Local visitors, naturally attracted by the perfection of the light and its apparent adaptability for interior lighting, may be informed that it is not only very elegant, but very expensive. Eventually some person will insist on having it at any price, and having once secured its introduction, experience will doubtless lead to greater economy and corresponding profit. This may not be a really practical plan, but we believe the incandescent lamp is now fairly cut loose from the laboratory, and should be taken up at once as a branch of electric lighting for which there is now a profitable demand, to be extended almost indefinitely as the process of production be improved and cheapened, as it certainly will be in the hands of intelligent and ingenious men.

THE UNDERGROUND COMMISSION AND ITS WORK.

The various electrical companies having been duly requested to send in such plans as they might have devised for the burying of their wires, the Commission on Electrical Subways, located in pleasant quarters at the Metropolitan Hotel, calmly awaited their reception in order that they might proceed at once with the obsequies. Instead, however, of rendering that advice and assistance which as interested parties the companies might reasonably be expected

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to offer, they all apparently with one accord began to make excuse.

One had made diligent inquiries throughout the civilized world, being not only willing but anxious to adopt a feasible plan, if there was such a thing in existence, but there appeared to be none.

Another, out of due consideration for the comfort of the commission, refrained from submitting any plan adapted to its own wires, because it might not harmonize with the system to be eventually adopted.

The representative of a district company stated that they owned no poles, and consequently had no street system, but that their attention was being devoted to subterranean plans, none of which appeared to be adapted to their service.

Having failed to obtain any suggestions from those who might be supposed to have thoroughly examined the history and practice of underground electrical work, the commission turned for relief to the inventors who have been laboring many long and weary years in this direction, each being the sole possessor of the only system which would appease the apparent wrath of the metropolitan editors who had sounded the death knell of overhead wires.

At last their opportunity had arrived, and the commission, previously embarrassed because no plan existed, found themselves equally at a loss to determine which of the hundreds presented was really the best. There were inventors with pipes, cables, and conduits; bare wires and insulated wires; curbstone, lampost and sidewalk systems; glass supports, porcelain supports and wooden supports. Here was an elegant reclining chair system, with a little railway along the bottom of a three-foot tube. Along its sides were to be arranged the various cables necessary to provide for the thousand and one conductors, while the subterranean lineman, recumbent in luxurious ease, was whirled along with celerity and despatch. Neither climbers, hatchet nor tie wires dangled from his belt. Judging simply from the surroundings and the serene expression upon his countenance as it appeared in the picture spread out for examination, the lineman considered the arrangement a success. There was a tinge of sadness in the negative replies which were made when President Loew blandly inquired of the several inventors if their systems were in actual operation.

We must admit that in our own nature there exists a certain repugnance toward going underground; but if we must go, we should elect to travel on a little electric railway in a reclining chair, our pathway illuminated by an incandescent lamp, and with continuous telephonic communication established for the benefit of ourselves and the friends whom we had left upon the surface above.

An impression prevails that no actual results have been accomplished by the commission. This is a grievous error. For many years the electricians of the various companies who were supposed to be interested in this important subject have patiently listened to the multitudinous variations which have been played upon this underground harp of a thousand strings. They have not been paid liberal salaries with their duties confined to this particular class of work; but when most deeply engaged in matters requiring uninterrupted attention their thoughts have been diverted by the entrance of gentlemen who had solved the problem, bearing with them models of fearful and wonderful construction, accompanied by samples of all varieties of natural products, and artificial compounds of rosin, bitumen, petroleum, glass, sand, sawdust and old gum shoes. All this is ended. The headquarters of the Commission on Electrical Subways is the Mecca toward which these pilgrims are now journeying. If nothing more is accomplished, the commission is fairly entitled to the thanks of certain deserving and hard-working members of the electrical community who have been diligently engaged for years in proving that their particular systems could not be made to work through underground wires.

A MYSTERY EXPLAINED.

The editors of this journal are always pleased to receive items of news of general interest from every quarter, and we think we may venture to say that the business manager is more than pleased to receive advertisements from responsible parties, for insertion, at the usual rates, in the columns set apart for that purpose, in which the advantages of the goods of the advertiser over those of his competitors are convincingly set forth, and his energy and enterprise duly extolled. Sometimes, however, careless people send the editor a news item with an advertisement concealed within it, which by some singular fatality fails to appear in either department of our journal. We think it due to ourselves to explain that this is on account of the office cat. This sagacious animal was brought up in an advertising agency. He was fed on advertisements, and has become as sharp-scented for them as other cats are for fresh fish. It sometimes happens that an item is sent us for publication reading something like this:—

The Jobson-Hobson Electrical Disseminating Company have just installed a plant, embracing one Robson generator and two tin handles, fitted with sponges, in the celebrated medical institute of Doctor Dobson, at Oshkosh cross-roads.

Dr. D., and a number of other prominent and enterprising citizens are so convinced of the superiority of the Jobson-Hobson system over that of Wobson, that they have formed a local company, of which nearly all the stock has been subscribed. The few remaining shares are advancing in value with unprecedented rapidity, and the backers of Wobson are becoming deeply discouraged.

This might, and probably in many cases would, escape the attention of the care-burdened editor, but it never escapes the attention of the office cat. It is a matter, so to speak, of bread-and-butter with him. Before the editor could protest, even if he wanted to, the office cat seizes and swallows the concluding paragraph, and carefully deposits the remainder upon the editorial table.

A WARNING TO PROMOTERS.

The tragic death of Albert D. Swan, of Lawrence, Mass., at the hands of a man who believed himself to have been wronged, should be seriously considered by those who engage in financial enterprises of a speculative character. There are too often beggared victims who, driven to desperation and heedless of their own lives or reputations, will not hesitate at murder in order to satisfy the spirit of revenge. There is frequently a cause for such an act which cannot be reached by legal punishment. If the golden rule was more carefully observed these tragedies would be less frequent.

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ARTICLES.

THE BEST FORM OF DYNAMO.[1]

A VIEW of this subject allotted by our president, is rather a delicate task for one belonging to the rank and file of a dynamo builder. The problem of dynamo construction is susceptible of a large number of solutions, each form being the "best" if our claims as manufacturers are accredited. There is no distinctive feature, however, from which something cannot be learned.

The art has advanced so far from the experimental stage, that to-day we are enabled to judge of the merits or demerits of a new construction from a practical standpoint, aided only now and then by theoretical considerations. We have learned by costly experience that not always is that dynamo which gives absolutely the highest electrical efficiency the best for commercial results. We have found that the mechanical engineers cannot be ignored in the designing of electrical machinery; that the salient points in the best experience in construction of engines and analogous machinery should be closely studied and followed.

The best dynamo is that which with good economy operates continuously with the least expense; one that does not require the constant attention of an expert, by no means, however, underrating efficiency in an attendant; one which has no delicate parts liable to derangement, one in which all the parts are accessible for cleaning and proper attention. Large journals, heavy framework and substantial construction throughout are not to be overlooked in dynamo machinery any more than in a locomotive.

A tendency, which is becoming less prevalent, has been toward developing the greatest possible current with a given size or weight of machine. The construction in this case is generally too delicate, and all parts are overworked to such a degree that they are constantly giving way. The effect of this upon the commercial operator and public generally has been disastrous, establishing the impression that all electrical appliances are inherently unreliable.

The latter constructions are more durable, less delicate as to details, and generally more satisfactory; although it is true they may occupy a slightly increased floor space. The armature, being that part of the dynamo in which the current is primarily produced, it may be considered first in order. Its arrangement should be substantial, compact, and with as few irregularities as possible, which would tend to fan the air; yet be thoroughly ventilated, which is the most natural means of keeping down the temperature of the conductor. The core should in every case be laminated to prevent the generation of currents in the masses of metal. The armature conductors should not be too large for the same reason; and the mounting of the coils or armature conductor should be such as to avoid abrasion of the insulation from expansion and contraction, or from centrifugal action in or upon the same. They should, moreover, be accessible in all cases for cleaning and repairs. These coils being the seat of the development of the electromotive force, they should be so disposed that every portion, if possible, be subjected to the inductive influence of the field magnets.

I have taken special interest in this feature, and find that the average in the forms of machines ordinarily cited as examples is less than 50 per cent. for that portion of each convolution of the generating conductor which is productive of electromotive force, the remainder not only being idle, but offering wasteful resistance to the currents set up in the useful portions. The immense importance of this point will be readily appreciated and requires no further comment here.

Waste space on the armature should not occur, although unavoidable in some forms, such as the disc armatures. The mounting and relation of the armature should be such in regard to the field that no more than two magnetic reversals occur with each revolution.

The winding of the coils one upon the other is found to interfere materially in case of repairs, and is sometimes a fruitful source of short-circuiting, but cannot well be avoided in the cylindrical or Siemens form of armature.

The divisions of the armature conductor into coils should be as numerous as is practicable, especially where the electromotive force is high, as it facilitates the insulation of the various parts from each other, and lessens the sparking and consequent wear and tear of the collector or commutator. Another effect of increasing importance is a tendency to lessen the undulatory character of the current generated, rendering it more harmless to life, and at the same time reducing its inductive effect upon adjacent line wires, which so annoy our neighbors (?), who, I regret to say, are not always charitably disposed. (The remarkable facility with which some of our worthy contemporaries either detect or imagine the effect of induction from electric light wires is only comparable with the sensitiveness of the instruments which they handle.)

The commutator should be substantial, the insulation between the segments and at the ends should be ample, and of a character not liable to shrink, char, or absorb oil or moisture; the segments should be deep, to secure long service; the size should not be too small to secure proper electrical construction, nor so large that the friction of the collection brushes shall be felt, nor the centrifugal tendency on the segments operate to loosen them from their place.

The field magnets should be given special attention. Their arrangement should be that which would at once strike the practical mind as being the most natural. An effort should be made to avoid sharp angles or corners in both the polar extensions and the yokepiece at the rear.

The helices or coils should be of the most regular form, cylindrical being, perhaps, superior in point of economy.

The disposition of the quantity or masses of metal in the various parts of the field magnet should be also looked to carefully.

In some forms of machines a small core and coil may be found arranged to maintain the magnetic potential of a comparatively immense mass at the pole-piece. This arrangement is obviously bad. That form of electro-magnet most often met with in telegraph construction is, perhaps, of all forms, the best, and should be followed as closely as possible in designing fields for dynamo machinery. The arrangement of multiple coils parallel to each other for the magnetizing of a single pole-piece is adverse to high efficiency, as the adjacent parts of separate coils tend to mutually demagnetize each other. This effect should also be looked to with regard to the arrangement of other parts of the field magnets; often the polar extension and yoke, or any of the means by which the magnetic circuit is completed, are badly arranged as regards each other.

The arrangement of the field, as shown in the Gramme continuous current and Weston machines, that is, where the magnetic potential is developed midway in the length of the continuous core or piece of metal, labors under one disadvantage, which may be noticed as follows: Considering only one half of the entire field of the machine, which would consist now of two coils, a north and south pole and yoke, we have the ordinary electro-magnet; and the opposite facing the said first set, although integral therewith, would perform the office of a keeper and tend to satisfy the potential at the poles.

The current in the two coils on the opposite side of the poles must then do the double work of first overcoming this adverse tendency of the lines of the force and magnetic potential, and secondly, of aiding in maintaining such potential at the poles. This result is of course mutual with regard to the two sets of magnets facing each other.

1. Read by E. A. Sperry, of Chicago, before the National Electric Light Association, August 20th, 1885.

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The efficiency, however, of this form of field is brought up to standard from the fact that only one half of the mass of the pole-piece depends upon each coil or helix for the maintenance of magnetic potential.

The distance between the pole-piece and the surface of a revolving armature should not be too slight. Experience has determined that the increased efficiency is more than neutralized by the increased heating effect; the space is more valuable for keeping down the temperature of the conductor upon the armature and lessening liability to damage resulting from a high rotative speed. Substantial bands should also be provided to guard against the latter.

It is of no little interest to note the changes marking the successive stages of development of any given machine as showing the effect of experience upon the more theoretical considerations, and bearings may be taken upon these successive stages which may guide the close observer in the selection of his apparatus, or the designer in the future development of any special form of dynamo machine.

A beautiful analogy may be traced between the distribution of the potential in the ordinary electrical circuit, and that in what may be known as the "magnetic circuit" of a dynamo. In the first the arrangement of the potential at various points depends upon the resistance encountered by the electric current at these points varing in degree with the amount of such resistance. This law holds true also in the magnetic potential at various points in the magnetic circuit of the machine. Here, the points of greatest resistance occur at the space which is between the polar extension and the armature core, and the degree of magnetic potential required at this point to perform the necessary work, will be determined by the distance between the magnetic surfaces at these points. For the highest economy in the field, therefore, this magnetic circuit should be closed, and no space whatever provided between said armature core and said polar extension. This, of course, being impossible, the aim should be as near an approach as is practicable, for reason that the cost of maintaining the magnetism of the field is the function of the degree of potential required at the pole-piece, and when this is low, only a small amount of current is required to maintain the field. In this case, a large iron core with a comparatively small amount of wire upon it, will suffice to do the work.

An erroneous idea, now going out of practice, has been to leave magnetic projections on the surface of the armature, which tend to short circuit and satisfy the magnetic potential of the field without compelling the induction to take place directly through the armature coils. The importance of as nearly closed a magnetic circuit as possible, was pointed out as early as 1873, by Lord Elphinstone, who, at that time, forecast the peculiarity which may now be seen as the result of practice and long experience in the art, viz: the distance separating the armature and field magnet, the masses of metal, the efficiency at the field and general construction of the machine are determined by the character of the current to be developed; the greater number of convolutions and the greater thickness of insulation between all the parts of the armature coil and its supporting core in case of high tension currents, requires a greater space for the coils, diminishing the size of the armature core and increasing its distance from the field.

The magnetic potential of the latter being therefore greater, its mass is lessened in both the pole-piece and core, with a proportionately large amount of wire, is required in the helices, and corresponding increase of energy required to maintain the magnetic potential. This peculiarity and difference may be seen in the two classes of arc machines. belonging respectively to the so-called high-tension and low-tension systems, and is even more readily apparent in the leading machines belonging to the two respective fields of electric lighting. This points to the fact that the internal efficiency of a machine varies with a certain function of the electromotive force of the current generated, being less for a high-tension machine and greater in a machine producing greater quantity and lower electromotive force.

In electric lighting there are many other features of vital importance, aside from the mere electrical efficiency of the generator; for instance, the cost of construction of lines, the distance at which the various operated devices may be maintained with economy, the economy of transmitting the current on the exterior circuit of lines, and possibly there also exists a difference in the transformation of electricity into light energy by the use of the voltaic arc—all, perhaps, in favor of the high-tension system; while the cost of maintenance, liability to leakage and attendant expenses, especially on underground systems, the danger to life and property, and the economy of construction and facility in coupling, especially in the incandescent system, are decidedly in favor of the lower tension.

The preponderance of the advantages in either of these systems must depend entirely upon the circumstances and upon the judgment of the investigator, no two plants being attended by exactly the same conditions.

The matters going to determine the best form of dynamo, as has been briefly pointed out, are so numerous, and the various forms of dynamos being best adapted each for its peculiar sphere, that a general formula, prescribing that form which is best in all cases, would be impossible. The art, however, has brought dynamo machinery, the construction of which at first was attended by so many difficulties of a high scientific nature, down to a sufficiently practical basis, so that good judgment with regard to ordinary mechanisms of a higher order are relevant to the more salient features, and may be depended upon largely in guiding those interested in investigating this class of apparatus.

THE ELECTRIC RAILWAY IN NEW YORK.[1]

BY F. A. PICKERNELL.

For several years past, the question of running the New York elevated railroads by electricity has been agitated. This culminated in a meeting held in New York city on the 18th of November, 1884, at which were present representatives of the Edison, Daft, Field, Siemens, Brush, and Bentley-Knight electric railways, and also of the New York elevated railway. At this, and five subsequent meetings, it was decided to test each system of applying electricity as a motive power for railways upon a certain portion of the elevated road. To pass judgment as to the relative values of the various systems, the following gentlemen were appointed to form a board of arbitrators: Sir William Thomson, Prof. Charles R. Cross, George B. Roberts, James H. Rutter, and Robert Harris. It was, moreover, decided to finish the test, if possible, within 90 days. This time has long since elapsed, and the waiting public have heard no report.

During this time, however, a vast amount of work has been done, and great difficulties surmounted. The great delays have been occasioned by the mechanical application of the electric-motor to the heavy and quickly moving trains. In the various systems to be tested, a third rail will be employed; and the laying of this, combined with its proper insulation, has consumed a vast amount of time.

In spite of all difficulties, the Daft company have completed their preparations, and are ready to start. As in other systems, the electric circuit is made from the dynamo to the central rail, through the collector to the motor, thence to the wheels and rails, and back to the dynamo. This company have laid their third rail upon the Ninth avenue line, commencing at 14th street. This rail is insulated by the Daft patent insulator, which prevents water from making a connection from rail to sleeper, thus insuring good insulation in all weathers. The road is further equipped

1. *Science.*

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by completing the electrical contacts at the joints of the outer rails.

At the end of this line the company have located their central station. They have placed in position a large William Wright engine, with the necessary boilers and shafting. Two 50-h.p. Daft dynamos are now in position, and, later, a third will be erected to relieve the others, in case of accident. The wires are carried from the station to the rails through the streets upon poles.

The motor, Benjamin Franklin, has been for some weeks finished, and has been thoroughly tested. The motor is fourteen feet six inches long, and six feet nine inches wide, and weighs nine tons. The schematic drawing, fig. 1, will show the manner in which the motor is arranged. No attempt is made here to reproduce the proportions of the Benjamin Franklin. One of the largest-sized Daft motors,

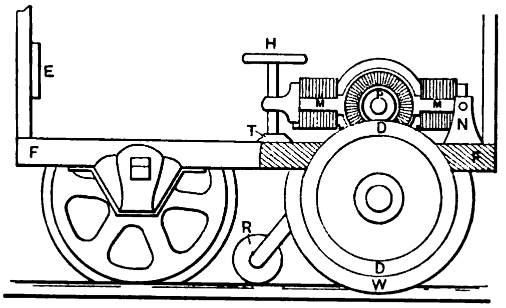

Fig. 1

MM, is mounted upon the truck FF. The motor is hung so that it turns about N as an axis. The other end is supported by the screw H. The maximum capacity of this motor is 300 ampères, with an electromotive force of 185 volts. The power is transmitted from the motor to the wheels by the grooved friction-gearing P and DD. P is keyed to the armature shaft, and DD to the drive-wheel shaft. The flange of the drive-wheel, on the farther side, is shown at W. These gears are duplicated on the other side of the motor. The amount of pressure upon the friction-gears is regulated by the screw H. This screw is also advantageous in case of repairs, for by means of it the motor may be moved completely off its friction bearings. The support, N, of one end of the motor, is cushioned with heavy strips of rubber, as is also the cap T, upon which the screw rests. The trucks are likewise cushioned, thus allowing freedom of motion in any direction, and insuring perfect accommodation, on the part of the motor, to any irregularities in the road-bed.

The connection with the middle rail is made by means of a heavy bronze wheel 14 inches in diameter, R. This being fastened to an arm, may be raised or lowered, thus allowing discontinuities in the central rail, of which there are several in the Ninth avenue line, to be safely passed. The wiring is all underneath the frame, and is enclosed in wooden sheathing. The device for controlling the motor is placed at the end of the cab at E. This is a device of sliding contacts, worked by a handle similar to the throttle in the locomotive-cab, which raises or lowers the resistance in the field-magnet circuit, thus varying the amount of current, and consequently the strength of field and speed of motor. There is also a complete cut-out in circuit. The motor is thus under complete control, it being possible to run fast or slow. The motor may be stopped either by the cut-out, or by lifting the contact-wheel. The system is further provided with an automatic cut-out, which breaks the circuit when the current reaches a certain strength, at the same time ringing a bell at the central station, warning the engineer at the central station that there is trouble on the road.

The reversing-gear is simply four brushes connected by suitable links, so that a movement in one direction applies one pair of brushes, while a movement in the other applies the opposite pair. In the motor Benjamin Franklin, the ordinary hand-brake will be employed; but later, some form of air or electric brake will be used. This motor is a very substantial affair, as its weight (nine tons) would show. The experiments will be performed as soon as Mr. Daft is at leisure to commence them.

The Edison and Field companies have combined, and are preparing to test their system upon the Second avenue line. The length of this line from Chatham street to Harlem is 7.44 miles, only part of which, however, will be traversed by the electric railway. Although this company have not brought their work so near completion as the Daft company, still they have done a deal of hard work. They have located their central station upon 24th street, and have provided there a 250-h.p. Whitehill & Smith engine, with the necessary boilers and shafting. The Edison dynamos have not yet been set in position, nor has any wiring been done.

In this system, the central rail has to be very carefully insulated on account of the comparatively high electromotive force employed (some 600 volts). To this end, the rails will be insulated by resting upon glass shoes, which will be protected from the jar of passing trains by a thin strip of rubber. As the glass shoes have not been delivered, the rails have not been laid.

The work upon the motor has progressed slowly on account of the many difficulties offered. The original arrangement, shown in the *New York World*, April 26, 1885, has given way to several newer forms suggested by it. The latest form, and the one to be completed, is shown in the schematic drawing, fig. 2.

In this system, every truck will be provided with a motor, thus making every car independent. In fig 2, A is

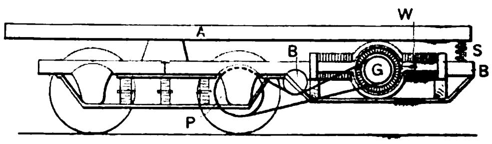

Fig. 2

the bottom of the car, T is the ordinary railway truck used upon any car. To apply the motor, the truck is prolonged to B, and is supported by the springs. This spring is hung from a roller capable of side motion, thus allowing the truck to accommodate itself to curves. The motor used is a compound-wound Siemens, and is so designed that, with an external electromotive force of 600 volts, it will revolve at a constant speed of 600 revolutions per minute. The power is transmitted from the armature to the pulley C by means of a Weston friction-clutch. This friction-clutch, W, is worked by a wheel similar to the ordinary brake-wheel, one wheel working both friction-clutches of one truck. The power is transmitted from the pulley G to the pulley P, keyed to the axle of the driving-wheels, by means of a heavy leather belt of peculiar construction. In order to obtain more bearing surface for the belt, it is carried around the pulley B. This same arrangement is reproduced on the other side of the truck.

The motor itself is movable, so that the tension of the belt may be varied at will. The contact with the middle rail is made by means of brushes sliding upon it. The brushes are mounted on the ends of a bar which prevents their dropping down when another road is passed, and thus short circuiting the track. The brushes are held in position by springs which allow them to turn, and thus insures a drag of the brushes at all times, instead of a push, thus allowing the joints in the rails to be smoothly passed. The reversing is accomplished as in the Daft, by employing an extra pair of brushes. The speed of the car will be controlled by the friction-brake, the motor running constantly at a uniform speed. The Eames vacuum brake will be employed, the pump of which will be run by the motor.

It will be seen from the above, that the Edison-Field

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combination are working upon a new principle. This system will have many advantages peculiar to itself. Each car will be independent, and the cars composing the train will start off simultaneously, thus relieving the elevated structure of the great strain caused by the locomotive when starting. The constantly revolving armature, on account of its high speed, and consequently great momentum, will help start the train, thus relieving the engine at the central station of sudden and great strains. As the load on the car increases, the traction likewise increases. The weight, moreover, of a train of this kind, is more evenly distributed than in one moved by a locomotive.

The electric motor, in general, possesses advantages which are of special value on an elevated road. It is possible to balance an electric motor, thus relieving the structure of the constant vibration caused by the quickly moving locomotive. Its freedom from dust and smoke, as well as its economy, insure its immediate introduction.

Although the progress in introducing the electric motor on the New York elevated railway has not been so rapid as had been anticipated by enthusiasts, still the progress has been steady, and in the right direction. It is, perhaps, remarkable, that more companies have not commenced operations ; but when the magnitude of the task is realized, and the patents held by a few parties are inspected, the reason is seen. However, several other companies intend to commence operations in the immediate future, the plans of which are now maturing.

BAZIN'S ROTATIVE BATTERY.[1]

This apparatus, which is designed for electric lighting purposes, is a combination of Poggendorff's bichromate battery, and of mechanical depolarization by rotation. While the principle is not new, the careful tests of its efficiency which have been made will be found of interest to those who are experimenting in this direction. The arrangement adopted is shown in figure 1.

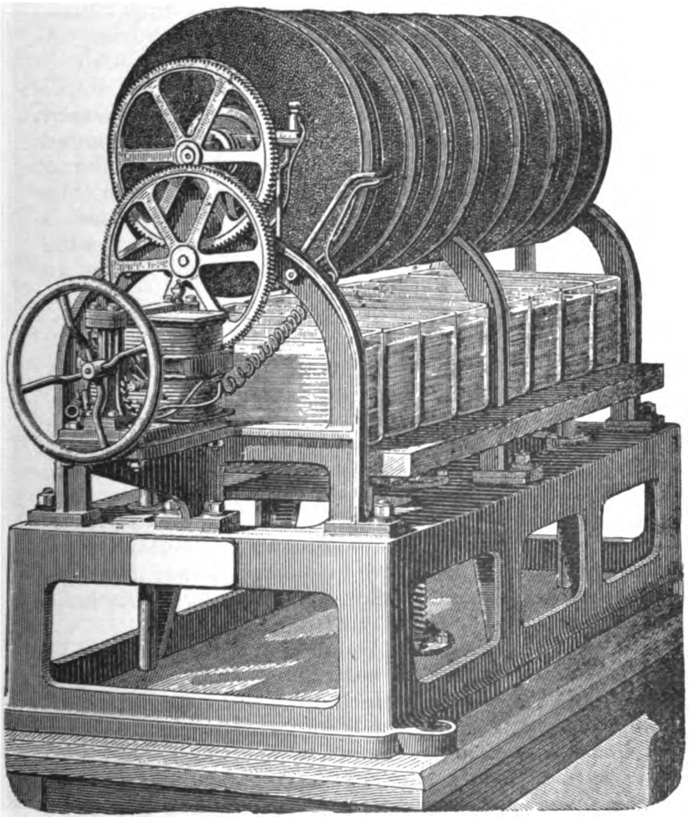

FIGURE 1.

The zincs and the carbons are mounted upon one and the same axle, to which a slow and regular rotatory movement is communicated by the aid of a small electric motor supplied by a distinct element. The battery represented in figure 1 comprises eight elements, seven of which are utilized in the outer circuit; each element is composed of a disc of zinc placed between two discs of carbon; the liquid is contained in rectangular troughs, which hold each three litres. The immersion of the elements is regulated by raising up a platform on which all the troughs are placed. The immersion may vary from zero to one-third of the surface of the discs, according to the degree of exhaustion of the liquids.

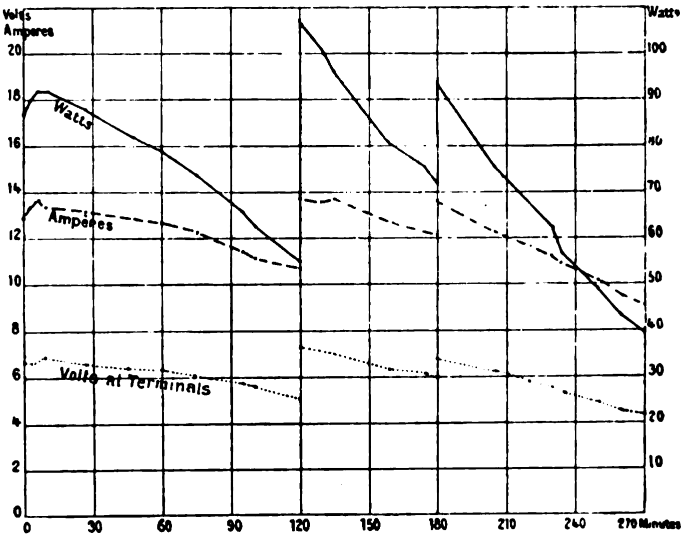

FIGURE 2.—Diagram of the Discharge.

The diameter of the discs, and the number of the elements in series, may be made to vary according to the duration of the effects to be produced in the outer circuit. M. Bazin has constructed other models with oscillating elements, but we have not had the opportunity of experimenting with them. In all, the movement is communicated at once to the carbons and the zincs, which in our opinion is an inconvenience, since the liquid conveyed out of the element by the zinc during rotation is used in pure loss.

However it may be, here are without comments the results obtained in the best of the three complete discharges which we have had the opportunity of effecting with the rotative battery.

The battery used in the experiments comprised eight elements; one of these elements served to supply the motor which gives the axle supporting the zincs and the carbons. a rotation of about one revolution per minute; the other seven elements are connected in series on the outer circuit. This outer circuit is composed, beside the connecting wires, of a resistance of 0·1 ohm in nickel silver, 6 millimetres in diameter, four Cruto lamps of 6 volts, arranged in parallel, and an ampèremeter.

The current was measured by taking the differences of potential at the extremities of the resistance of 0·1 ohm with a movable frame galvanometer (Deprez-d'Arsonval's model) previously calibrated by a total resistance of 2,000 ohms, and giving under these conditions 50 divisions per volt on each side of the scale. The sum of the two readings gave the current directly in tenths of an ampère.

The same apparatus enabled us to measure the differences of available potential at the extremities of the battery, by raising the total resistance of the circuit of the galvanometer to 10,000 ohms.

The arithmetical mean of the two readings of each side of the scale gave this difference in tenths of a volt.

The corresponding available power in watts was ob-

1. M. Hospitalier in *L'Electricien.*

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tained by multiplying the current by the difference of potential.

The total quantity of electricity supplied, as well as the total electric energy, were obtained by measuring the corresponding surfaces of the subjoined diagram, figure 2, by means of Amsler's planimeter.

Each of the elements contained 3 litres of liquid. This liquid was an acidulated solution of bichromate of potash; 125 grammes bichromate, and 300 grammes sulphuric acid per litre.

The discharge was effected in three stages:

1. Continuous discharge for two hours (from 0 to 120 minutes). Stoppage of 2 hours 20 minutes.

2. Continuous discharge for one hour, with a greater immersion of the elements (from 120 to 180 minutes).

3. Total immersion of the elements and continuous discharge for 90 minutes, without stoppage between the second and the third stage.

The elbows of the curves at the points 120 and 180 minutes indicate distinctly the augmentations obtained in the yield by the decrease of the internal resistance resulting from the increase of surfaces.

The subjoined table summarizes the principal conditions of the total discharge, the factors of which are shown at each instant by the diagram, figure 2.

Duration of discharge..................	4½	hours.
Quantity of electricity supplied..........	198,000	coulombs.
" " "	55	ampère hours.
Total available work....................	0·45	h. p. hour.
Total consumption of zinc (motor not included)...............................	1126	grms.
Mean consumption of zinc per element...	160·9	"
Effective consumption per ampère hour..	2·93	"
Theoretic consumption..................	1·213	"
Ratio of the two consumptions.	2·4	"
Mean power of battery during a discharge..................................	75	watts.
Mean power of an element..............	10·74	"
Maximum power of an element..........	15·	"
Initial electromotive power (7 elements in series)..............................	13·1	volts.
Final do. do.	11·9	"

If we calculate the consumption of the battery as referred to h. p. hours, and taking account of the circumstance that the seven elements during this discharge have yielded 0·45 h. p. hour, we find in round numbers:

Zinc..................................	2½	kilos.
Bichromate of potash..................	5½	"
Sulphuric acid	13	"
Total volume of solution...............	45	litres.

Such are the present working conditions of the Bazin battery. To justify the insufficiency of these results, M. Bazin points out that our experiments have been made with the first apparatus constructed for his own studies, and necessarily incomplete. He promises by October next more perfect apparatus, in which we shall find decided improvements. We shall therefore await further experiments before passing a final judgment.

THE COMPASS IN IRON SHIPS.

THE Philadelphia *Times* gives an interesting account of a curious industry—adjusting the compasses of iron ships. The business, it says, is monopolized by three persons in the United States—two in New York and one in Philadelphia. An iron ship, said one of these professionals, is a great magnet. The magnetism of such a ship is technically known as "permanent," from having received the same from some other magnet itself styled permanent. The position the vessel occupies in the shipyard while in course of building is the principal feature in the shaping of her magnetic influence. It may seem incredible, but a vessel lying due north and south on the stocks will be highly charged with magnetism—so highly, in fact, that the nicest calculations and most skillful adjustment of neutralizing magnets is requisite to correct its influenee on the compass, and with the greatest care errors are made, which involve more or less trouble in the directing of the ships' course.

Every blow struck upon the iron plates of the sides, upon the rivets, or even by the calker, has a pronounced effect upon the ship's magnetism. It is well known that in certain processes of iron working, workmen, after striking the metal in one direction for a few minutes, are compelled to reverse the direction of their blows so as to change the polarity in order to prevent the fine particles of loose metal from adhering to their tools. In ship building it is impossible to reverse the manner of striking, and the result is that the magnetic currents are not equalized.

If a vessel that was built north and south in the yard travels generally north and south she loses a great portion of her magnetism, and a corresponding change is noticeable in her compass.

The lines of magnetism always run in a contrary direction to the position the ship occupied in building. It is said that the quality, ductility and grain of the metal used in the construction of the vessel have a great deal to do with the magnetic currents. It sometimes happens that the greatest accuracy that can be secured will not prevent a variation of three or four points from the true point. Occasionally it happens that, for illustration, a variation of but one point will be noticed when the ship is headed northeast, but when headed southeast five or six points of variation exist. The magnets used to neutralize the ship's magnetism consist of large bars of iron, spheres, spheroids, coils and, in fact, iron of almost every shape. These are placed in different portions of the vessel and exert a greater permanent influence the further away they are placed. When placed near the compass they "make the needle wild." If the engines are changed during the trip, if new boilers are shipped, iron taken aboard or "patches" put on the sides, the magnetism of the ship is proportionally disturbed and a readjustment is necessary. Usually an adjustment for all practical purposes will secure safety, so far as the compass is concerned, for a year or probably longer; but cases are reported where iron ships but forty-eight hours out from port have been wrecked in consequence of a change in the ship's magnetism producing a variation of the needle not calculable. These are rare, however.

ELECTRIC LAUNCHES IN THE RUSSIAN FLEET.

As a result of experiments made by the Russian War Department last summer at Cronstadt with electric launches, a part of the Russian cruising fleet has been supplied with these vessels to be used for night attack. The design is by Lieut. Treritinoff. Each launch carries an electric battery of 200 accumulators, which, section by section, are capable of furnishing propelling power for from 15 to 20 hours, and with a velocity of from five to six knots the launch is good for from 75 to 100 miles.

These launches have been found peculiarly adapted for carrying an armed crew on warlike expeditions at night, because, unlike the steam launch, they make no noisy puffing and are good for a long distance. Boats, even with muffled oars, are more or less noisy, and, besides, are very slow. Here, then, is a case where the electric launch is invaluable, because economy, of course, is not a requirement, speed and silence being the requisites.

We are not told how many men these launches will carry, nor how many are assigned to a single vessel. They can be swung over the side and launched from davits like ordinary boats, the men boarding after the launch is safely afloat.—*Bulletin des Telephones.*

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THE UNDERGROUND WIRES OF CHICAGO.

BY C. C. HASKINS.

The interest felt just now in electrical circles on the underground question, the action taken by various cities of the Union, looking to the removal of overhead wires of every description, would seem to render apropos a history of this whole matter, not only for information, but to give to the originators the credit for an idea which has been canvassed, pro and con, throughout nearly the whole civilized world, and place its local progress here on record for future reference. In practical underground electrical work, embracing all systems, Chicago is in advance of any city in America, if not in the world.

THE ORIGINAL IDEA.

The history of the present underground enactments dates back as far as 1875. In that year our present city electrician, Prof. John P. Barrett, then chief operator of the fire alarm department of Chicago, drafted a resolution embodying the vital parts of the existing enactments. This resolution was introduced into the city council and referred to the committee on fire department, where it was earnestly fought by Gen. Anson Stager, Norman Williams, Esq., superintendent J. J. S. Wilson, and Chas. H. Summers, electrician of the Western Union company. Mr. E. B. Chandler, then superintendent of the city fire alarm department, also doubted the wisdom of the resolution, and it was finally placed on file—pigeon-holed in the desk of the committee.

Matters now rested in *statu quo* until Prof. Barrett by promotion had been made superintendent of the fire alarm department, when, not having seen any reason for change of opinion, he renewed the warfare on overhead wires. In the meantime no little inimical feeling had been engendered in the minds of his opponents, and the "ground hog ordinance," as it was facetiously called, and the "original ground hog," were the subjects of many a pleasantry, and bitter comment as well.

THE ORDINANCE BEFORE THE COUNCIL.

At the council meeting of May 2, 1881, the committee on judiciary, to whom the ordinance of Prof. Barrett had been referred, consisting of Daniel L. Shorey, John M. Smyth, and John M. Clark, reported favorably and recommended its passage. Alderman Clark moved the report be laid over, which motion prevailed.

The ordinance succinctly forbade the erection of any new telegraph work in the central portion of Chicago after the 1st of January, 1883; within a farther limit, after the 1st of January, 1884; and throughout the rest of the city after 1885, with a penalty of $100 for each offense for each wire, pole, or line, or electric conductor erected or maintained in violation of the law. All permits previously given were to terminate and cease at the dates and in the districts mentioned, the penalty being $50 for each and every day the violation should be continued after the 1st of January, 1885; ordered all electrical conductors placed underground, subject to the supervision and control of the commissioner of public works, and required special permits from that department. The city lines were exempted.

Subsequently, during the same year, the present existing law was passed as a substitute for the previously proposed ordinance. The provisions of this ordinance may be briefly stated as follows:

Sec. 1 forbids any and all new work within the city limits, under penalty of $100 for each offense, and each day of continued maintenance shall constitute a new offense.

Sec. 2 forbids the maintenance of any existing lines after May 1, 1883, under penalty of $50 for each wire, pole or line, each day it is so maintained in violation of law.

Sec. 3 requires all existing lines to be laid under the streets and alleys of the city.

Secs. 4, 5, 6 and 7 specify how, when, and where the work of burying the lines shall be done. The law to take effect at once.

THE LAW EVADED.

Matters had now reached a crisis, and something had to be done. The constitutionality of the ordinance was questioned, the right of the city to revoke previously granted permits was doubted, and while repairs were permitted at all times on proper application to the superintendent of the fire alarm telegraph, every now and again bright new wire and insulators grew to their places in the dusk of night or gray of the early morning; and despite the spirit of accommodation and leniency for which the "original ground hog" is proverbial, there were occasional difficulties with parties who became defendants in suits for violation of the law.

In a commendable spirit of accommodation a special provision was made by the council permitting a line of poles and wires from 39th street, along Clark, to enable the Mutual Union to get their southern lines over the forbidden ground to their office, at the request of that company. This contained a proviso that these should all be removed by the 1st of May, 1883, and in default of such removal the Mayor was empowered to cut the lines without notice to the company.

OVERHEAD WIRES OFFICIALLY CUT.

On the day named the lines were intact, and working as usual. The Mayor had instructed the superintendent of city telegraph to be ready, and during the day, accompanied by a corps of assistants, he went quietly to the city limits, south, and proceeded to sever the lines.

The destruction of the entire line of 60-foot poles, which would undoubtedly fall if the strain was removed by cutting the wires, was a serious matter, and might possibly result in further destruction of the property of innocent parties, if indeed it did not peril life. In order to sever every wire without subjecting the line to this sudden and tremendous strain, only one wire was cut between each two consecutive poles, the next circuit being cut on the next section, thus distributing the unusual tension throughout as many sections (30) as there were conductors on the poles.

The surprise of the operating department at the main office was as perfect as the discontinuance was complete. One after another line gave out mysteriously, until an oppressive silence reigned where but a few moments previously, all was in perfect operation.

THE QUESTION IN THE COURTS.

The matter was carried before the city council, and eventually into court for adjustment. The judge before whom the case came decided that inasmuch as the telegraph company had accepted the law and agreed to abide by its provisions, there was no enactment which would legally permit them to replace the disconnected lines; that although the severing of these wires by the authorities was irregular, being once severed they could not legally be re-connected by the company.

The matter was finally compromised, the company being permitted to repair the damage and continue business, subject to certain restrictions, the company agreeing to use their utmost diligence in replacing their overhead wires by underground lines, substituting the latter for the former as fast as consistent with uninterrupted service, and the discontinuance of these overhead lines left to the discretion of the authorities.

The Western Union had in the meantime obtained an injunction against the city, preventing its interference with their lines erected before the ordinance was adopted. As a matter of compromise, to test the validity of the law, a test case was agreed upon by the city's legal advisers and the attorneys for the telegraph and telephone companies, and in the interim plenary powers were delegated to the

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city electrician, to deal with the latter parties as in his judgment seemed best, his action being governed by the willingness or refusal of the companies to perform their part and use due diligence in carrying out the provisions of the ordinance. The injunction obtained by the Western Union was aimed against interference with the maintenance of lines already up when the ordinance was passed, but had no reference to new work.

THE BEGINNING OF SUBTERRANEAN WORK.

At the meeting of the council, July 31st, 1882—to digress a little—the Chicago Sectional Electrical Underground Co. came to the front. By enactment of that body, Henry Corwith, Wm. C. Grant, Edward S. Dryer, Wm. H. Bradley and Edward Koch were granted, for a term of 25 years, permission to construct and maintain conduits throughout the city, for electrical purposes. The act provided that all the lines of conduits should be underground, save at the tunnels, and under the supervision and control of the commissioner of public works—subject to any future legislation relative to underground lines—and to be commenced within six months from the passage of the act. The ordinance required them to permit others to use their conduits, and in case of dispute as to rental compensation, the terms to be settled by three arbitrators. The company may form a corporation. The usual restrictions as to space occupied, damage to and repairs of thoroughfares, etc., including a bond of $5,000, with sureties, are embodied in the ordinance, and the personal liabilities of the several parties are defined.

The Postal Telegraph Co. was then demanding right of way into the city. A contract was entered into with Elisha Gray by the underground company, and a conduit was laid between the Postal office, corner of Lasalle and Washington, and the city limits. This conduit, the first and last of its kind, probably, was a rectangular iron box, constructed of ¼ or ⅜ iron, in sections, fastened together. The box was covered with an iron lid, and within were placed two Patterson cables, which are still in use by the Postal company. The size of the box is about 6 x 8 inches. The Underground company is to-day using a far different conduit, both as to shape and material, as will be seen below.

The credit of originating the underground idea, as we have seen, belongs to Prof. Barrett; but in addition to this, he is entitled to the credit of having first carried the plan into successful operation, and this is how it came about. A portion of the most aristocratic residence locality on the north side lay along a projected line of fire alarm telegraph, and in order to successfully build the line without legal interference, the superintendent made all the necessary preparations, and one fine Sunday the good church folks saw a handsome line of poles and wires erected before their very eyes, without a possibility of preventing the desecration.

There was almost no end to the complaint. The immediate discharge of the head of the city fire alarm department was imperatively demanded. A council of war was held, and the professor's only suggestion was that the wires should go underground, for which a specified sum was asked, and the next morning the money lay upon his desk. The wires (kerite) were laid in iron pipes coated with coal tar and oil, and the pole line removed. This was in 1876, and the wires are to-day, after nine years continuous service, as perfect as ever, and still doing daily duty.

"This one-half mile of conduit," according to one of the system's bitterest enemies—who has since changed his mind, by the way,—"this little piece, put down by Barrett, is what has raised hob with us all."

The next attempt was made here in the winter of '78–'79. A "Brooks" oil cable was placed in the Washington street tunnel, containing 50 wires for the fire department, and the following spring a similar cable was placed for the telephone company in the same tunnel, and two similar cables in the Lasalle street tunnel. These were oil cables—or cables run through iron pipes filled with oil—at one extremity of which a tank supplied oil for any minute leaks that might occur.

The fire department pipe has been discontinued. The telephone company are still using the Washington tunnel cable, with good results. A fire last spring destroyed the north terminals of the Lasalle tunnel, and a Patterson cable was substituted.

In the fall of 1881, Geo. W. Bonnell brought out an underground system, which was peculiar to say the least of it. Each wire was drawn through thin glass tubes, and these, placed in lead pipe were surrounded by a waxy insulation, a compound of paraffine and tallow, or something similar. The theory was that while the cable might be bent and the glass broken, the fragments would prevent contact, while the insulation would be impervious to moisture. Naked wires were used.

A line of this was commenced in 1881, from Washington near Dearborn street, to about 26th and Stewart avenue, for the Chicago and Western Indiana R. R. Co., and another piece for the Mutual Union—which at that time was being opposed by the W. U. company—down Dearborn street. Both these cables were abandoned as worthless, neither being completed.

In the summer of 1882, a 20-wire Patterson cable was laid for the same railroad company, from 94 Washington, over the same route as before. On the completion of the company's new depot at Polk street this year, the portion north of Polk was abandoned.

In 1883 the two cable iron box conduit mentioned before, connecting the Postal company's office with the city limits was laid.

Of underground conduits we have had several forms. The Western Indiana cables were laid in wooden boxes, without other protection, the Postal in an iron box—both of which are well filled to-day with silt—the B. & O. company used wrought iron pipes laid in a box filled with asphalt, containing Clark, Day's kerite, and Patterson wires, the Western Union laid kerite wires in iron pipes, the city adopted the Dorsett pipes with kerite wires, the telephone company have both kerite and Callender cables as well as Patterson. The Bankers and Merchants' used kerite wires, in iron pipe.

In addition to the above a short section, some 300 feet, of a novel underground arrangement is in use in Lincoln Park, which contains the positive and negative wires of an arc plant. The compound here used is a plastic insulator, in a wooden box about 3 by 5 inches, in which the naked wires are strung upon porcelain insulators. This has been in regular use for some four or five months, and is working in a perfectly satisfactory manner.

While on several occasions there have been casualties arising from the influx of sewer or burning gas in several of these conduits, there have been none of that nature, that I am aware of, in those formed of the Dorsett material, which as a narrator of facts I feel bound to state.

The iron pipes used by the Bankers and Merchants' have been unfortunate in this regard on two or three occasions, and the Western Union came near losing two valuable men by a similar catastrophe. Mr. Summers, electrician, and Mr. Brotherhood, engineer, were both badly injured by an explosion of burning gas.

The presence of gases in these pipes is destructive to all forms of gutta-percha, Chatterton's compound, etc., used in joining wires, and the only remedy seems to be, in some form, to keep these gases out of the pipes, for the two-fold purpose of protecting joints and preventing either suffocation or dangerous explosion, when man-holes are opened for repairs or inspection; and this air, gas, water, oil or sewage prevention has thus far only been accomplished by the Dorsett conduit.

January 23, 1885, corporation counsel F. S. Winston, Jr., in response to a request for information, made a re-

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port to the council, embodying a letter from J. P. Barrett, superintendent city telegraph, in which the following figures appear, showing the approximate miles of wires already placed beneath the streets and alleys of Chicago:

Bankers and Merchants' Telegraph Co.	400	miles.
Postal Telegraph Co.	180	"
Chicago Telephone Co.	28	"
Western Indiana R. R. Co.	50	"
City Fire Alarm Telegraph	60	"
A total of	718	"

"In addition to these, preparations are made, or being made, by which as soon as possible there will be placed by the W. U. Telegraph Co., 500 miles; Baltimore and Ohio Telegraph Co., 250 miles, approximately."

Such was the status of affairs at the opening of the present year. Of course nothing in the way of progress could be accomplished beyond preparation, until frost was out of the ground. As soon, however, as the weather permitted, active preparations were commenced and the work rapidly pushed forward during the season.

One short paragraph from an interview with Prof. Barrett, on the occasion of a Philadelphia committee's interview in December, 1883, may briefly give his opinion then, which experience has not changed. To the question, "To sum it all up, then, you consider that the city has adopted the best form of conduit yet invented?" he answered:

"The best answer to that question is the statement that I have spent five years examining and testing devices for this purpose, and have finally recommended the use of the Dorsett system by the city."

Not a dollar has been paid by the city in repairs in any one of these conduits.

A new form of cable box is being laid by the Western Electric Co. for the Chicago Telephone Co. This consists of Patterson cables in a wooden box, which is subsequently to be filled with cement.

Nine hundred wires will be thus laid in the west division. The Standard Cable Co. have a similar contract for 650 wires on the north side.

There are at present, of various forms of underground conduits and cables within the city limits something over 400 miles of wires laid by the Western Electric Co., and these embrace every variety of wire from electric light to telephone conductors; 516 miles additional are now being laid by this company.

The Sectional Underground Co., using the Dorsett conduit, have made a checker board of the city, their routes running through every alternate street on the south side from the main river to Van Buren street, and from the south branch to the lake, an area of about 2½ miles square. They have in this space, each trench containing two pipes, 22,100 feet of conduit, which, with fourteen 2-inch holes in each pipe gives an abundance of room for the needs of the city and the various companies for a long time. On the north side there are 10,420 feet of this double conduit laid and the work still going on, while on the west side they have hardly commenced, having but 4,460 feet down. The total of Dorsett conduit down to-day is a little over seven miles, each representing fourteen longitudinal round spaces of two inches diameter. Electric light systems are thus separated from wires carrying lighter currents.

The city, too, is continuing the work. The arrangement of the system is such that every block is easily reached, either from front or rear, and Prof. Barrett is pushing the work as rapidly as possible. From every box the wires will dive at once beneath the sidewalk, and thence out of sight around the block, if need be, to the nearest lateral, not to appear again above ground till it reaches its central station.

In the course of a few days not a wire belonging to the city will show above ground, on the south side, and the north and west divisions will be cleared soon after; while in a comparatively short time all the overhead wires which have been so loudly complained of, will have departed from our city's thoroughfares forever.

PRIVATE INSTALLATIONS OF ELECTRIC LIGHTING.[1]

BY RALPH H. C. NEVILE.

Having for many years desired to use the electric light for domestic lighting, the author could not see his way to doing so while arc lights—and those anything but perfect—were all that were commercially practicable. When, however, incandescent lights were introduced, he determined to make the experiment as soon as possible. Happening to have a six h.p. portable engine some ten years old, which he had been using for pumping and for driving a saw, he determined to try this for the purpose, although warned that in all probability difficulties would arise in respect of the governing, as proved to be the case, in consequence of the governor being one of the old-fashioned kind, with heavy balls revolving at a slow speed. In the course of last summer he arranged with Messrs. Edmundson, Westminster, to carry out the wiring of the house, and in the autumn obtained from them a Siemen's SD 9 compound shunt-wound dynamo, and completed the installation sufficiently to judge of the merits of electricity *versus* gas, which had been the previous illuminant. The total number of lamps in the house is 125, divided over some 50 rooms and offices. The maximum number of lamps hitherto required at one time for purposes other than those of experiment has been 60. All the main wires within the house have been laid to admit of the full number being used, and even of an increase to 150 or 200. The engine and dynamo are stationed in a shed about 180 yards distant from the point where the overhead cables enter the house; in this shed, also, is the saw-table, so that by removing the belt from the dynamo and substituting one to the countershaft of the saw the latter can be driven by the engine when it is not required for lighting. The dynamo is driven direct from the fly-wheel of the engine by a 4-inch linked leather belt, which suits the purpose very well, there being no uneven places caused by lacing or other joint to cause any unsteadiness in the running of the dynamo. Owing to the centres of the dynamo-pulley and fly-wheel shaft being necessarily somewhat close together, the belt has to be kept rather tight when required to transmit the whole power of the engine. This, however, has never yet been required, except for experimental purposes. The current generated is led from the dynamo to a set of switches, by which it can be distributed into five separate circuits. The first of these is the circuit exciting the field-magnets of the dynamo itself. The second circuit furnishes lights for the engine shed and the carpenter's shop adjoining. The third goes to a school-house near. The fourth goes, by an overhead cable, to the house, a branch being taken off to light the stables. The fifth circuit goes to a board, on which are fixed 100 lamps for experimental purposes; and this circuit is also intended to furnish current to secondary batteries, or accumulators, which the author hopes to introduce before very long The switches distributing these currents are two-way, so that the current can either be sent out direct or can be passed previously through one of Ayrton & Perry's spring ammeters, whereby the amount of current in use on any one or more of these circuits can at any time be ascertained without causing any interruption in the light. The ammeter in use, being constructed to register up to only 20 ampères, has been provided with two shunts of thick german silver wire, so that by using one or other of these the reading on the ammeter is reduced to one-half or one-third of the total amount passing; in this way the total current of 60 ampères can be registered. The current for use in the house is led from the dynamo room to the roof in an insulated cable of fourteen No. 16 wires (0·065 inch thick), and is thence taken overhead through a bare cable of the same size, suspended on poles, to the point at which it enters the house, where it is connected to a larger cable

1. Read before the Institution of Mechanical Engineers, Lincoln, England, August 4.

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of nineteen No. 14 wires (0.085 inch). This cable has been provided in order to admit of a larger number of lamps being used in the house at some future time without disturbing the wiring, &c., inside the house. It leads well into the middle of the house, giving off on its way smaller branches to light sections of rooms, and then connects to a smaller cable, which again is reduced to a still smaller one before reaching the far end of the house. These cables all give off smaller branches to light the various rooms both up and down stairs. At their junctions with the mains the branches are fitted with fusible cut-outs, so that, in the event of any short circuit occurring of sufficient magnitude to cause any undue heating of the branch, the fusible plug would go, and would cut off that section. Most of the switches used have also fusible plugs in them, and are of the quick-breaking type, so that they cannot be left in such a position as to form an arc. The lamps used are mostly 100 volt 20 c.p. lamps of the Edison and Swan make, but in some cases two 50 volt 10 candle lamps placed in series are used, instead of one 20 candle lamp. This is principally the case in passages, which are thus better lighted by the greater diffusion of the light, and, moreover, it is never required to light one of these lamps without the other. In the chapel there is a hanging chandelier with 20 lamps, in which the current is conveyed to the lamps by the suspending wires, and the chandelier is so arranged that, for the purpose of replacing lamps which have failed, it can be raised or lowered without disturbing any connections. In most other cases the lamps have either been left simply attached to the ends of the wires or have been fixed to the old gas-brackets. In the author's private workshop are a few lamps attached to flexible wires, which are very convenient for placing in various positions for working, and especially for turning. The installation was first used in November last, and everything worked very satisfactorily, with the exception of the governor, which proved utterly unsuitable, the inertia being so great that its position would remain the same for a very considerable variation of speed; so much so that, although an adjustable resistance of considerable magnitude had been inserted in the circuit exciting the field-magnets of the dynamo, it was found impossible, even with this, to control the electromotive force to the point required. Frequently when resistance was inserted, thereby lessening the work done by the dynamo, the engine, in consequence of the lightened load, would increase its speed sufficiently to bring up the electromotive force to its old point. The consequence was that it was necessary to keep the steam pressure in the boiler almost absolutely constant, or rather, to allow it so to vary in proportion to the load that it should keep the electromotive force constant. This was found exceedingly difficult in practice, and it was soon seen that it would be necessary to get some more efficient kind of governor. Having seen the working of Mr. Richardson's electrical regulator, and being much pleased with its principle of action and with its performance, the author decided to try it, and one was accordingly adapted to his engine. Although this old-fashioned type of engine does not lend itself very readily to the introduction of the necessary valve, the object was attained in a very efficient though possibly rather unsightly manner, by taking the steam from the top of the safety-valve fitting and passing it through the throttle-valve actuated by the governor, and thence downwards into the steam chest. The regulating part of this governor consists of a double solenoid magnet, placed vertically, and wound with insulated copper wire, within which works a double core, and to the cross-piece at the bottom of the cores is linked the long arm of a lever, the short arm of which presses upon the spindle of a double-beat Cornish valve that controls the admission of the steam to the steam chest. For incandescent lighting in parallel, the wire, on bobbins, is placed in shunt circuit between the main leads, and the size of wire used is adjusted according to the electromotive force which it is desired to maintain between the mains, so that when the electromotive force is at the right point the cores are suspended within the solenoids by their attraction. Inasmuch as the resistance of the solenoids is fixed, any increase in electromotive force causes an increased current to flow through them, whereby the cores are immediately attracted with an increased force, and are caused to move upwards, thereby acting through the lever to close the valve until the electromotive force has been brought down again to its normal amount. The required movement of the valve is exceedingly small, and this method appears to be the best suited for electric lighting. An automatic expansion gear, on which the governor might be caused to act, has the disadvantage that, when but few lights are burning, the steam is cut off at so early a period of the stroke that unless the fly-wheel is exceedingly heavy a fluctuation occurs in the light during each revolution of the fly-wheel, somewhat analogous, though, of course, in a much smaller degree, to the unpleasant bobbing generally seen in electric lights driven by a gas engine where there are no accumulators. In a large engine, where economy of coal has to be considered, probably the best way would be to have an expansion gear actuated by hand, which can be set approximately to the expansion required, leaving the throttle valve to regulate the speed finally. But where perfect steadiness is desired it is probably better not to cut off much before half-stroke, especially if a single-cylinder engine is used. The use of accumulators as regulators would, of course, prevent a great deal of the fluctuation, and would permit of the steam being cut off much earlier without causing any apparent unsteadiness in the light. The electric governor was fixed on the engine, and worked for the first time on January 13 last. The improvement was remarkable, the lights remaining steady without the sudden alternations of brightness and dullness which had occurred before. But it was still found that with any considerable variation of boiler pressure or of load the electromotive force in the mains varied more than was thought conducive to long life in the lamps. As, however, it was found that, by augmenting or diminishing the weight suspended from the core bars, the electromotive force could be brought back to its normal amount, it occurred to the author to fix an upright cylinder in direct communication with the boiler, and to make its piston rod press upwards on the core bars, the diameter of the cylinder being experimentally determined by observing the weight necessary to be added or removed for certain variations in boiler pressure. This arrangement caused a very great improvement; and when the load was approximately the same it maintained the electromotive force constant under very considerable variation of steam pressure. When, however, the load was varied very considerably, say from 1 lamp to 100, it was found that more variation took place in the electromotive force than was desirable. The arrangement was accordingly modified by causing the piston rod to act upon a lever, and by introducing a second cylinder supplied with steam from the steam chest, the second piston rod acting upon the same lever, but upon the other side of the fulcrum. The end of the lever was furnished with a steel knife-edge, bearing against another knife-edge set at right angles to it upon the prolongation of the core bars. The cylinders were also both of them made larger, and were placed so that they could either of them be moved nearer to or further from the fulcrum of the lever, whereby the resultant effect of their differential power could be easily adjusted. This arrangement answered very well indeed, and it was found that the lights could be varied from 1 to 100, and the boiler pressure from 30 lbs. to 60 lbs., with but very slight variation of electromotive force in the mains, provided, of course, there was sufficient steam to do the work required. It is also quite easy to cause the electromotive force to rise as the load on the engine increases—or, in other words, as more currents pass through the main—by simply giving greater leverage to the piston connected with the steam chest. In fact, with this arrangement, the

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electromotive force can be maintained practically constant, or can be made to vary in any desired manner with variations of steam pressure or of load. The main leads to the house having a resistance of about 0·2 ohm, there is a loss of about 12 volts of electromotive force when 60 ampères of current are passing along them between the terminals of the dynamo and the house; whereas when only one or two ampères are passing the loss is practically *nil*. Hence if the electromotive force were maintained constant in the dynamo-room, it would fall at the house as more lights are turned on. In the case of an engine controlled by an isochronous governor this difficulty is supposed to be met by the compound winding of the dynamo machine. There are, however, several disadvantages in that plan. One is that each dynamo ought to be specially wound for the electromotive force desired to be maintained, and for the external resistance between the lighting centre and the dynamo; and if either the electromotive force of lamps used or the external resistance is varied, the adjustment of the machine is destroyed. This also in a great measure prevents the use of reserve machines for a large installation where several circuits are used, because the reserve machines cannot suit all the circuits equally. Another disadvantage in a compound machine is that, if it be used in conjunction with secondary batteries, and the engine be permitted to slow down before the connection between the dynamo and the batteries is broken, the current from these last will flow back through the dynamo, and will reverse the polarity of the magnets if it be a compound machine; and when next started, the batteries and dynamo will be wrongly connected, and considerable harm may ensue both to batteries and to dynamo.

The plain shunt-wound machine is free from these objections; but the disadvantage has hitherto been that as more lights were put on the electromotive force fell just when it should rise. With an electrical governor this can be obviated, as indicated above, by a suitable arrangement of the piston actuated by the steam from the steam chest. But a still better plan is probably that adopted by the author, of taking certain points as lighting-centres, and keeping the electromotive force between them constant. For this purpose small wires are connected with the mains at the required points, and the current to actuate the governor is taken off there, instead of direct from the terminals of the dynamo. One of the points is just outside the house, where the wires enter; and the other point is in a room. The electromotive force between one cable and the other cable is maintained constant by the governor. This arrangement could easily be applied to a large installation for a town, each engine and dynamo having its particular district. The cables would be led direct to the district, and governor wires would be led back from the district to the engine governor. The arrangement of splitting up the required power into several small engines, instead of employing only one or two very large engines, permits of this plan; and also requires very much less reserve of power to provide against a break-down. For example, if the lighting of a town be estimated to require 2,000 i. h. p., and this be divided between two engines of 1,000 i.h.p. each, it will be necessary to have either one or two similar large engines in reserve, according as it is intended to provide against a single or double break-down. If, however, the same power be divided amongst 40 engines of 50 i. h. p. each, it will only be necessary to have a reserve of one or two of these smaller engines for providing against similar contingencies. A simple arrangement of switches would then at once permit of a reserve engine with its regulator being switched on to any particular circuit on which it might be required, owing either to a temporary break-down or to a special extra demand for current. Another advantage of an electrical governor over any arrangement of isochronous governor, however perfect, is that the electrical regulator takes its regulation from the mains, and not from the engine; consequently, if there be any loss, either by slip of belt, or by extra heat in the field-magnet circuit or the armature, causing increased resistance, this will be compensated by the electrical governor at once driving the engine so much faster as to make up for it. On one occasion when experimenting with the governor, this was specially noticeable; for when the load got rather heavy, the belt at the time being rather too slack, the engine suddenly increased its speed considerably, but the voltmeter remained at the same point, and the dynamo was found to be running at just about its ordinary speed, the extra speed of the engine being evidently caused by slip of belt. When the lever arrangement was completed, several experiments were made by Mr. Richardson and the author, the results of which were as follows. When the load on the engine was allowed to remain constant, with only one lamp alight, it was found that while the steam pressure was allowed to vary between 31 lbs. and 55 lbs. the electromotive remained constant at 90 volts. Afterwards, with the same extent of variation in steam pressure, and with the load also varying from 1 lamp to 91 lamps, the electromotive force varied only two volts, namely from 91 volts to 93 volts. The following are the particulars of this second set of trials:—

Steam Pressure.	Number of Lamps.	Electromotive Force.	Steam Pressure.	Number of Lamps.	Electromotive Force.
Lbs.		Volts.	Lbs.		Volts.
55	1	92	45	61	92
55	11	91	35	50	92
55	21	91	32	41	93
55	31	91	32	31	93
55	41	92	32	30	92
55	51	93	30	71	92
55	61	92½	35	91	92
55	71	92	40	91	93
55	81	92	45	91	93
55	91	92	50	91	92½
50	91	92	50	91	92

The arrangement of the governor has since been modified, in order to obtain a neater-looking arrangement and also better results. Here there is also the advantage that, if an ordinary centrifugal governor be added to the engine —which may be done as a measure of safety, in view of a wire breaking or of the main driving belt coming off; and which must be done if the engine be required to do other work, such as sawing or pumping, at times when the dynamo is not running—the throttle valve will still be compensated by the lever, which would not be the case if the compensating arrangement were attached only to the solenoid. A specimen of the combined electrical and centrifugal governor is exhibited. When the cores of the solenoid are in the most favorable position, the difference of pull caused by a small movement of them is very slight; and the movement required to open or close the valve is very small. Through a valve similar to the one shown, steam sufficient to indicate 55 h. p. has been passed with a lift of only 0·1 inch, and with a difference of less than 5 lbs. between the pressure in the boiler and in the steam chest. When it is desired to vary the electromotive force in the mains, a set of adjustable resistance coils is inserted in the governor circuit; by increasing these resistances, a higher electromotive force is required to drive the normal current through the solenoid, and thus to close the valve. In this way the speed of the engine and the electromotive force in the main wires may be varied to almost any required extent, and from a point however distant from the engine. The author has one set of these coils fixed in the circuit in the dynamo room, and another in the house; and by moving either of these the resistance may be increased or diminished, producing a corresponding variation in the electromotive force. This is found a great convenience when exceedingly exact electromotive forces are required for experimental work, which sometimes cannot be carried on in the immediate neighborhood of the dynamo machine. It may also be arranged practically to dispense with the necessity of any telegraph or signal to the engine room,

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because a switch and set of coils placed in any convenient position afford the means of varying the light as desired, without any reference to the engine driver, whose work then consists simply in seeing that sufficient steam and water are maintained in the boiler, and that all bearings are kept duly oiled. In the case also of an engine doing any other work, where it is desired to vary its speed from a distance, the same governing arrangement may be applied by causing the engine to drive a small dynamo just sufficient to furnish electricity for the electrical regulator. The electromotive force in the mains would then furnish at any desired point an indication of the speed of the engine at any moment; and a switch and set of resistance coils would afford the means of altering the speed to any other desired rate. As the amount of current required for driving the regulator is only small, the coils and switch may be made very small and compact; so that in a theatre, for example, they might be placed in the prompter's box, and the whole system would then be under his immediate control. The introduction of this governor has, in the author's opinion, contributed very largely to the duration of the lamps used. From the first start until the end of last year the time of running was 370 hours; and during that time with the old governor five lamps gave out, although they were all new when the installation was started; the average current during that time was 16 ampères Up to January 13 last, when the new governor was first introduced, the time of running was 477 hours, and 13 lamps had given out; probably also many of the others had been damaged. Nevertheless during the 487 hours running in February, March, and April, although the average current used had increased owing to the extension of the installation, only ten lamps gave out; and during the 84 hours running in June only two lamps gave out. Hence it appears that a good governor will soon save its own cost by an increased life for the lamps. Thus far reference has been made solely to incandescent lighting in parallel; but for arc lighting in series the advantages of a governor of this description are very conspicuous. Probably the best system of driving arc lights in series is by the use of a series-wound dynamo, especially if a compound engine be used for the purpose, because then the steam-chest pressure remains approximately constant, and the speed varies approximately in accordance with the number of lamps in use. Here an isochronous governor is obviously altogether useless. An electrical governor, however, meets the case perfectly. Here the whole of the current to the lamps is led round the solenoids, which are, of course, made with fewer coils of a thicker wire. When any lamps are short-circuited, a momentary increase of current takes place, which instantly raises the cores in the solenoids, and shuts off the steam, reducing the engine to the required speed for the number of lamps left on. The following are particulars of some experiments made in 1883 by Professor Thompson, University College, Bristol, with a machine of this description :—

Lamps Alight.	Ampères of Current.
0	10·6 to 11·2
5	10·0 10·5
11	10·0 10·3
16	9·9 10·2
17	10·1 10·2

Before the introduction of this regulator very considerable trouble was experienced in keeping the speed at the proper point, and many of the fine-wire coils of the Brush lamps were destroyed by an excess of current going through the circuit. Now, however, the current has been effectually controlled, and any number of lamps can be switched in or out without any attention being paid to the engine. Here also an arrangement is introduced by which, should the main lead become accidentally severed, the engine is at once stopped. A small electro-magnet is introduced, round which the current is led with a few turns of wire. The magnet supports a weight of several pounds, which is attached to a lever so pivoted that, when on the cessation of the current the weight falls, the lever presses with great force on the top of the valve-spindle, and shuts off the steam altogether.

PLACING WIRES UNDERGROUND.[1]

There is no more important question before the electrical community of this city to-day, than the underground line problem. Every branch of business requiring the use of pole lines must shortly be brought face to face with its actual solution. While there may be a difference of opinion as to the authority of the state to compel the abandonment and practical destruction of the overhead plants which actually exist, and which have been constructed in accordance with the requirements of the proper authority, there can be little doubt that the building of a new aerial street line in the future may and probably will be absolutely prohibited in the cities of New York and Brooklyn.

As an instance of the present state of affairs I will call your attention to the dilemma in which the United States Illuminating Co. finds itself to-day. This corporation shares the business of electric lighting for streets with the Brush company in this city. Owing to the enlargement of the Grand Central depot, at 42d street, and the opening of Depew avenue, it was found necessary to abandon the 44th street station. A new station was equipped at the foot of 29th street, East River, to which the lighting circuits were to be led when the machinery was in readiness. This change required the construction of a new 50-wire line through 29th street, a distance of 3,600 feet. Upon application to the Commission on Electric Subways, a permit for this purpose was refused. I was informed by president Lynch that they would soon be turned out of their old station, that their customers could not be supplied from their other stations, and that nothing remained but for the Commission to provide a method by which they could comply with the law.

I narrate this incident merely to point out to you the conditions existing here to-day. To show also that overhead construction is not entirely prohibited, I will read you the following item from the *Evening Telegram*, of August 19th :

MORE TELEGRAPH POLES.

Gangs of workmen invaded West 28th street this week and erected telegraph poles along both sides of the street, against the protests of the residents, who claim that according to the law recently passed the telegraph companies have no right to erect any new poles, and must put the wires underground.

The members of this association being chiefly interested in arc lighting outside of the territory embraced in the Daly underground bill, this subject is not in every case one of immediate importance. It is not at all improbable, however, that other and smaller cities may enforce similar legislation, therefore it will be wise for you to consider the whole matter very carefully.

As you are, of course aware, the burying of the existing wires in New York is a complicated engineering problem. Not only are there thousands of wires owned by various companies and individuals, but the different systems require different subterranean facilities. Curiously enough the thunderbolts of the press have been hurled with the greatest force against the Western Union Telegraph Co. for its apparent calmness in ignoring the requirements of the law. As a matter of fact this company began placing wires underground about ten years ago, and employed an engineer for the express purpose of preparing plans for a general system, which was to include at least the Western Union, Metropolitan Telephone, Gold and Stock and American District Telegraph companies. I understand this work had to be abandoned mainly because of the destruction of the gutta-percha insulation by the effects of the

1. Read by Ralph W. Pope before the National Electric Light Association, New York, August 20th, 1885.

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steam heating pipes. The system adopted was that used in England—the simple drawing of gutta-percha cables through ordinary cast iron pipes. A similar plan was recently put in practice by the Commercial Cable, popularly known as the Mackay-Bennett Cable Co. In the upper part of the city, however, the cable is simply buried in the earth, being protected by a line of blue-stone flagging on the surface.

The Edison incandescent system, as you are doubtless aware, is entirely underground, and is too well-known to require attention at my hands. It was planned with a view to the requirements of the Edison company, but is apparently not suitable for all branches of the electrical service so far as has yet been demonstrated.

I am not aware that any arc lamp wires have as yet been placed underground in this city, neither have I learned of any plan by which they were to be so treated. I consider this the most difficult part of the work, and the most expensive, on account of the large wires required, and the necessarily high potential of the currents used. In reply to the question: "Is this feasible?" I say yes, it must be. It may be an expensive method, and more serious objections may arise in practice than we anticipate, but it is foolish to regard it as an impossibility, in this day of great engineering achievements. Its success requires plenty of dollars and plenty of sense. Furthermore, if arc lighting is to increase in this city it must be done, as no franchises for further aerial construction will be granted. As this crisis was bound to come, I think it was well timed, for the reason that reconstruction of the lines in this city would soon be necessary under any circumstances, and if lines must be abandoned it is less wasteful to destroy those already depreciated in value and which should have earned their cost, rather than those which are in good condition. The lines of the electric lighting companies in New York are not of a permanent character. The poles are slender, and the fibrous covering with which the wires are supposed to be insulated may be seen hanging in threads from the weather beaten structures, as you pass along the streets. I don't know how long it was expected that these lines would endure, but they are apparently not long lived. The cost of placing them underground is an expense which I presume our lighting companies are at present scarcely prepared to assume. It will naturally vary in different localities and under given conditions.

In the absence of any plans presented by the companies, the New York Commissioners will devise means by which conduits or subways will be prepared with facilities for accommodating the wires of all companies. It is to be presumed that they will then notify all interested parties that by lease or purchase they may obtain perpetual rights in such subways to place their wires. No system will be approved which is not sufficiently comprehensive to meet the demand for all classes of service.

This leads to the question as to what plan is the best, and this must be finally decided by the Commissioners after examination of the various schemes presented, and their name is legion. I will not occupy your time by even calling your attention to the various theoretical devices presented, of which I understand there are over 250, as most of them can never be of any practical value, while but very few are in actual operation.

Of conduits which have been really used for this purpose, and have, therefore, been tested by experience, but two have been brought to my notice. These are the conduits which have been put down to some extent in Philadelphia and Chicago. The latter is known as the Dorsett underground conduit, and has been used in Chicago for over a year. The same material has, however, been in use underground in the form of sewer pipes for six or seven years without apparent disintegration. A conduit used in Philadelphia was troubled some time ago by explosions which arose from the accumulation of gas in the manholes. This was supposed to have been caused by leakage from the gas mains. While in Philadelphia last year I saw a line of arc lamps which I believe were supplied from wires through this conduit. With a little more time at my disposal I should have been glad to have looked into its details more thoroughly.

The conduit, as used in Chicago, appears worthy of attention, as being the most successful system of this class which has thus far stood the test of experience, and may now be seen in actual operation, occupied by telephone, telegraph, and electric light wires. It is made of concrete, formed by mixing asphaltum and silex, and is moulded and at the same time hammered into lengths of three feet, through which are formed at the same time longitudinal ducts, the whole having the general appearance of a tubular boiler. One end is provided with a flange, so that the sections may be securely joined, when they are cemented with the same material applied while hot, and a perfectly tight joint formed. At the corners of the streets manholes are provided, formed by the same material. These like the conduit itself are gas, sewage and water-proof. The material is said to have stood a government test of 5,500 pounds, crushing strain per cubic inch. It is also a practically perfect insulator; and the ducts are smooth and uniform inside, being about two inches in diameter. Mr. Callender informs me that he has drawn several miles of cable into them without any apparent damage from abrasion. This system was adopted over a year ago for the municipal wires in Chicago, and also by the Underground Conduit Co., of which Professor Elisha Gray is president.

A recent experiment, which will perhaps be of interest to you, appears to have fully demonstrated the insulating properties of the concrete, which being cheap may possibly be practically utilized in this novel manner. The test which was but an experiment, consisted in placing naked wires in one of these underground conduits for carrying electric light currents. The plant of 40 lights is still running successfully. While this proves conclusively that such wires may be safely run in the manner indicated, it was not intended to continue the arrangement permanently. The installation of the wires spoken of where they are liable to dampness or other interference at the terminals of the pipe, was very complete, and the insulation rendered very thorough, by the following process, which is given for the benefit of those interested: The wire, before drawing in, was thoroughly taped from the union between the naked copper and the outside wire, for a few inches at either conduit terminal into the pipe. A cork, slit to receive the wire, was then placed upon this latter, and crowded into the end of the conduit about an inch. Then this countersunk space was filled with the compound which completely insulated the wire at the terminals of the tube, and made these air, water and gas tight, at the same time. As some of the members present may have occasion to visit Chicago, I would suggest that it might be worth their while to satisfy themselves of the merits of this conduit, as can of course be done most effectually by examination and inquiry on the spot.

Whatever conduit may be used the individual insulation of wires is essential. The tests which have been made thus far with insulation for arc lamp wires under these conditions are exceedingly meagre. A series of tests are now being made by the Standard Underground Cable Co., of Pittsburg, which will doubtless be of value in this respect.

It is a peculiar trait of human nature that we prefer to profit by our own experience, rather than abide by the testimony of others. I would therefore respectfully suggest that such members as can do so, should after careful consideration of the subject undertake the construction of short experimental underground lines with a view not only to preparation for the future, but to ascertain for the benefit of the entire fraternity the best insulating material for subterranean arc wires. In cases where antagonistic legislation is threatened, the very fact that you are laboring in that

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direction may prevent your being forced to do so, hastily and against your will.

The burying of the wires in New York is a work of great magnitude, and should properly have been begun many years ago in order that we might have thoroughly learned our trade instead of undertaking so vast a job as mere apprentices in underground work.

My brief intercourse with the Commissioners leads me to believe that they fully realize the importance of performing the duty which has been placed upon them, with a proper regard for the continuance of all classes of service without interruption. When the task is finally completed, and the wires working satisfactorily, with bills all paid, and dividends appearing regularly and frequently, we may be happier—I am sure we shall be older.

THE DURABILITY OF DYNAMOS.

The subject of the life of a dynamo for electric lighting purposes, has been frequently brought to our attention by many who are anxious to see the electric light at their mills or works, but have been deterred from incurring the expense of an installation by the absurdly incorrect statements made, and often accepted, relative to the durability of a dynamo. Its life has been variously given at two years and upwards, an estimate so low as to be sufficiently absurd. If a dynamo be cursorily examined, it will be seen that the elements of "wear and tear" are but small. The field-magnets and pole-pieces of solid iron, carefully wound with layers of well insulated wire, present nothing for deterioration. The properly-constructed, well-fitted "armature" should last without fear of damage, with the exception of such parts as are liable to friction. In the bearings themselves, if properly lubricated, there can be no wear more than in any ordinary engine bearing, but it is in the "commutator" and the collecting "brushes" that "wear" must go on. We have here the copper brushes pressing against the copper bars of the armature commutator revolving at various speeds, and it is here, where there is a certain amount of friction, that there must not only be a certain loss of material in the brushes, but also in the commutator bars. This loss is certain and definitely small with a good dynamo and one carefully attended to, but with inferior dynamos and loose attention, when "sparking" occurs the brushes are soon worn down, and the bars getting "scored" sooner require being "turned" to get a smooth surface. The sparking of a dynamo must sooner or later ruin a commutator (but it is a considerable advantage to know that you possess a machine whose commutator can be easily replaced), as every spark means more or less metal destroyed.

In a paper recently read on "Electric Lighting for Steamships," it was mentioned that the dynamos on the "Himalaya" had an exciter of the Siemens type. It had been running constantly for two years, and had not had any repairs done to the commutator, which might be considered very good wear. Although this question is one of great interest as affecting the "maintenance" of an electric light installation it was not again referred to, but in a recent number of our contemporary, the *Electrical Review*, particulars are given by Mr. Ernest Berry of the first year's cost of the installation at the Prince's Theatre, London, and he remarks that the Siemens dynamo "is in as good condition as when it was first put down, with the exception of the wear on commutator (which, on being measured after 12 months' wear, was found to be $\frac{1}{16}$ths of an inch). The machine has used in that time 5½ pairs of brushes four inches wide." From the number of dynamos we have seen at various times, we should consider that in this case the "depreciation" of the dynamo and the cost of maintenance above the average. It was only a short time before this case met our attention that we carefully examined a dynamo, which was also used for a theatrical installation, in order to see what the loss had been on the commutator. It was a 250-light Edison machine, and had been constantly running for nearly 2½ years, and from the feel of the hand over the commutator, it was almost impossible to perceive that there was any wear. Applying a straight-edge, it was possible to perceive that the surface had been reduced to the extent of the thickness of a piece of writing paper. As regards the brushes, these were the same as originally fixed, and would still last for a longer period. In this machine (running at 820 revolutions per minute) sparking was never observed; the same may be said of the other Edison machines of the same type belonging to the same installation.

The wear and tear of this dynamo was practically almost *nil*, and granted that it received in the future the same attention it has had in the past, it would be almost impossible to fix the limit when the occasion would have arrived to replace the commutator with a new one. The average life of a dynamo may, therefore, be considered to be at a high figure, provided that due care be taken of the adjustment of the brushes; and its cost of maintenance as that of an occasional pair of brushes, and the removal of the commutator, the cost of which would have to be spread over a number of years.—*Mechanical World.*

HOW MACHINERY IS RUINED.

We have again beheld the results of "smart Aleck" engineers, those $10 per week men, who are expected to attend to their employers' horses, sweep up the shop, and what spare time they have attend to their boilers and engines. During the past week we were in one of the southern cities. The elegant hotel where we picked our teeth was lighted by electricity. One day the "thing" (I cannot bring myself down so low as to disgrace my loved profession by calling him an engineer) had keyed up his engine without letting the electrician know of it. About an hour after it started, somehow it got tired and stopped. Imagine the effect—house in mourning. Had melted linings of brasses; electrician mad; saw us and asked assistance; given; brasses changed in a few moments; engine started; enjoyed an evening with electrician; were chums eighteen years ago on a western railroad; expressed our mind plainly regarding "thing;" no good; employer believes that if a man can throw coal he is as good as can be. We have seen engineers around hotels who were porters and wood sawyers, and the only wonder is that we don't hear of more "Galveston" accidents. For "Contented's" benefit, allow us to inform him that we are not tramping in search of employment. We chose that cognomen because our work calls us all over the country, and because we are so situated as to be directly opposite the tramp. From that hypothesis we argue that he sails under the "contented" flag, because he is "uncontented."

—*Boston Journal of Commerce.* Tramp.

GIMLET-POINTED SCREWS OF 1755.

Mechanics of adult age can easily remember when gimlet-pointed screws came into use within the last 30 years, superseding the blunt pointed ones before used, and the former have been considered a modern invention. But we have lately seen half a dozen screws with excellent gimlet points, which were taken from an old piano, and bear unmistakeable evidences of age, and of having been made before screws were made by machinery. The piano is inscribed "Jacobus Kirckman, Fecit, Londini, 1755," and the screws are doubtless of that date. The most curious point in the case is that after such screws as these had been once made mechanics should have gone on using square-pointed screws for nearly a century.—Worcester, Mass., *Gazette.*

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THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 298.)

LEADING WIRES INTO OFFICES OR BUILDINGS.

It is said that there is a right way and a wrong way to do everything. It may be stated with equal truth that there are many right ways and many wrong ways to conduct wires into buildings, and it is one of the most characteristic marks of a first-class constructor that he suits his style of entering, and indeed all branches of his work, to the particular circumstances and conditions which he may find at any special time and place. Hence, it is hardly right or fair to say "Such a way is the proper way to do this" or "This only is the correct method of accomplishing what is required to be done." Take for example the following case. The main line is supported on poles and runs past the front of the building in which as a way office the wires are to be run. If a pole happens to be exactly in front of the office, it is only necessary to run the line wires direct from the insulator, into the building through hard-rubber tubes which are fitted into holes passing through the upper crossbar of the window frame, and when the wire ends are inside, they can be twisted up so as to prevent their egress, the inside wire being then attached to the twisted ends. If the pole is not opposite the building, a small terminal pole may be set there, or brackets and insulators may be fastened near the window, and the line from the nearest pole on each side run direct to the window insulator. This is one way —I do not, however, regard it as being the best.

If several wires are to be run in at a window, a good plan is to fix a heavy pine crossbar having the required number of hook insulators screwed into its beveled corner, over the outside of the window and to terminate all the wires thereon, by first twisting them round the hook, and then winding them back on themselves, or fastening them with binding wire. Stout copper wire, heavily insulated with rubber or kerite, is then passed through the window frame to connect with the inside wires, and after stripping about 14 inches of the ends of the insulated wires, and brightening about four inches of the line wire, the copper wire is wound closely round the latter, thus making the connection; the winding in all such cases requires to be begun at the point nearest the insulator and to progress outwardly. It is quite necessary that all connections made as above between the iron and copper wires be soldered as with other splices. They should, however, only be soldered at the outer end of the winding so that the end only, of the copper wire is homogeneously attached. The reason for this is that it sometimes becomes necessary to unwind the connection for testing purposes, which could not be done were the soldering to extend from end to end.

There is still another way of bringing the main line to the window which sometimes must perforce be adopted. It occasionally happens, that wires have to be run from the main line into the front of a building while the owner of the building will not permit any fixture, no matter how small, to be attached.

The only way in such cases, is to divide the wire as it runs past the building, and to insert an insulating substance between the divided ends. An ordinary glass insulator with the closed end punched out, may do, although it is better to have insulators prepared for this work after the style of the English shackle. A short wire may then be spliced to the main line on each side of the insulator and run straight to and through the window frame. These short wires ought to be insulated.

To enter a window from the top of a building, a batten or counterbrace may be fixed to overhang the wall, and the wire led first to a hook insulator attached to it, and dropped plumb, to a second hook in a block, close to the window, from which it may be run in. Whether it is preferable to let the wire run in the window at the top or bottom of the frame must be determined by circumstances.

If the inside wires are to be run near the ceiling the top is best. If on the contrary the objective point is near the floor the bottom is best, as it is an advantage to have as little inside work as possible. If also there are unoccupied holes, already bored in the frame, these should be used rather than make others. If there are no determining circumstances I would recommend the upper part of the frame, as being more out of the way. Wherever wires, no matter how thoroughly insulated, run over and are in contact with brick, stone or ironwork, they should be "cabled," a word which, when used in this connection, simply means wound round at the point of contact with a short piece of rubber-covered or kerite wire, so that not the circuit wire, but the wound wire, will touch the building. Gutta percha covered wire is not adapted for this, or for any open air work, as it oxidizes rapidly and cracks when exposed to the air, unless well covered with tape soaked in wood tar, which should frequently be re-tarred. The better way is not to use it at all. A very neat way to bring wires into a residence is to carry them from hook or insulator, to other hooks down the side wall, and then in through the cellar window frame, when from the cellar they may be run wherever wanted. This is very convenient if testing is afterwards to be done. If wires are to be run into a building from the roof, and it is not convenient to reach a window, a search should be made for well holes or unused flues. When the latter means of ingress is to be used, the wire is or may be guided to its destination by means of a string which is first dropped down with a pebble attached to it.

It sometimes occurs with city wires, that a circuit is already looped to a number of windows on the rear or side wall of a building; when this is so, and still another connection is to be made on the same side of the building, instead of dropping an entirely new loop from the roof to the required point, the best way is to make a branch loop from the nearest window already connected; and by so doing much wire can be saved.

Wherever hard-rubber tubes are employed in passing through a window frame, good practice requires that they shall be inclined downward to the outside, to prevent moisture from entering. Each entering wire should also be given, wherever possible, a bend downward between the last block or hook and the window, and the holes through window frames should invariably be bored at an upward angle from the outside, for the same purpose. If many wires have to enter a building, such for example as a telephone central office, a cupola or roof house is usually provided and surrounded by a suitable fixture to which the linewires are first attached, and from whence they are led into the cupola, where after passing the lightning arresters or dischargers they are connected to the office wires.

It is essential in conducting electric light wires into a building that the greatest care must be taken to prevent even the slightest degree of leakage. The New York Board of Fire Underwriters requires that all wires, machines and lamps are to be so mounted and secured as to insure complete and continuous insulation; and that in no case must "ground circuits" be employed, or any portion of the system be allowed to come into conducting connection with the earth through water or gas pipes, or otherwise. This being the case, it is evident that a single accidental earth contact or leak will not produce a very disastrous result, but the real danger is that it might remain unnoticed, and that a second ground connection or escape, would complete the ground circuit and probably be dangerous. Another requirement of the board of underwriters is that "Wherever wires are carried through walls, they must be surrounded by a special insulating tube." A porcelain, or porcelain-lined tube is the best, and like all other entering tubes must incline down towards the outside. The wires where they leave the tube must be heavily wrapped with strong insulating tape.

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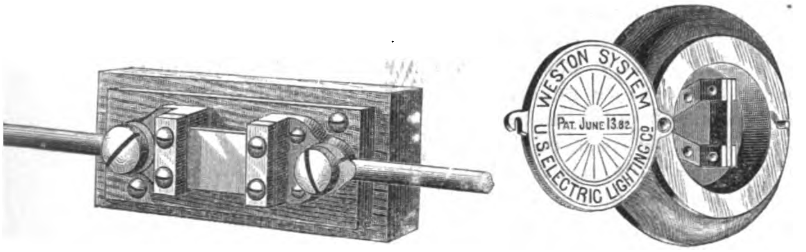
The useful device known as a "safety catch" should invariably be attached to electric light wires when carrying incandescent light currents. These should be applied just outside the building, and a good form is that employed by the U. S. Electric Light Co., which is shown in figures 24 and 25.



FIGURES 24 AND 25.

As clearly indicated in the figures, the "catch" consists in a thin strip of easily fusible alloy held between two metal clamps, and thus constituting a part of the circuit.

If from any cause the strength of current passing over the wires into the building becomes too great, the fusible strip is melted and breaks the circuit. It melts, moreover, at too low a temperature to cause damage from the dropping of the melted material.

Another most essential adjunct of electric wires entering a building is a cut-out switch located near the entrance of the building, but outside. This also is required by the New York Board of Fire Underwriters, in the following language: "Wherever electricity is carried into a building by conductors from an exterior source, a cut-out must be provided at a point as near as possible to the entrance to such building."

It is hardly necessary to describe any such cut-out, since its operation is well understood. It must in every case be affixed to a base of some incombustible material such as soapstone, slate, or very heavy plate glass, and it must certainly be arranged to close the one circuit before it opens the other, so that there will be no danger of forming an arc during its movement. If it becomes expedient from any reason to locate the cut-out inside the building, it should be so arranged that it can be operated from the outside also; it should have an indicating signal attached, visible from both the outside and inside of the building, to denote whether the house wires are in circuit or not; and it is quite indispensable that the action of the instrument be automatic when once started in either direction, as otherwise a person unacquainted with the apparatus might partly turn it, and thus establish an arc at that point. The entering holes should be at least a foot apart.

(*To be continued.*)

ELECTRICAL DEFINITIONS, NOMENCLATURE, AND NOTATION.[1]

WITH the rapid progress that has lately been made in electrical science and its applications, there has sprung up a new and fast-increasing class of practical electricians. These, partly from necessity and partly from well-meant respect, have adopted and applied the old terms and expressions which appeared suitable to their predecessors, as well as coined not a few new ones, until now their vocabulary is in considerable confusion, and, as all must admit, requires sifting and reform.

Nothing is more tantalizing and perplexing than the different modes of expression and symbols used by different authors, and sometimes by the same author, to explain and interpret one and the same thing or result. All this might be avoided if an international system of definitions, nomenclature, and notation was agreed upon and legalized. The rapidity with which the new definitions of the ohm, ampère, and volt (issued and legalized last spring at Paris by the International Congress of Electricians) were universally adopted shows this. These definitions should be still further extended to other electrical units. They should embrace a suitable system of notation, whereby electricians could represent in symbols and letters, terms, expressions, and formulæ of common occurrence, in a similar manner to that adopted by chemists in connection with chemical elements and their combinations. Last session the author promised a communication to the society on this subject, and, being again reminded by the secretary of his unfulfilled promise, he now submits a few of the more apparent instances where ambiguity or want of uniformity exists, with suggestions, in the hope that a discussion may follow, and that a committee of this society may be formed to consider and draw up a series of definitions, nomenclature, and notation that would be generally acceptable. The proposed committee might then confer with the French committee, also with a similar committee appointed by the British Association, and finally this important question should be referred to the International Congress of Electricians, in order that they may legalize and issue their decisions in a similar manner to that adopted by them in the case of the ohm, the ampère, and the volt. Undoubtedly, if such a course were adopted, most beneficial results would accrue to all concerned.

Only last November M. Hospitalier brought this subject prominently before the International Society of Electricians at Paris, and strongly advocated an investigation, so that you will no doubt have their support and concurrence.[2]

"Sur la proposition du Président, l'assemblée décide qu'une Commission spéciale sera nommée à l'effet de rechercher les meilleures méthodes à adopter pour les notations électriques et de codifier ces notations.

"M. le Président propose, au nom du Bureau, d'appeler à faire partie de la Commission des notations électriques.

"MM. Ed. Becquerel.	MM. H. Becquerel.
" E. E. Blavier.	" G. Cabanellas.
" Marié-Davy.	" J. Capentier.
" Tresca.	" Gauthier-Villars.
" Maurice Lévy.	" E. Hospitalier.
" G. Lippmann.	" D. Monnier.
" Félix Lucas.	" D. Napoli.
" Mercadier.	" Pollard.
" De Meritens.	" J. Raynaud.

M. V. Williot.

"L'assemblée adopte cette liste à l'unanimité."

Examples.—1. At the very outset students are perplexed by such different terms as "ordinary[3] or static or frictional or high-tension electricity." One author will tell his readers or students: "For a long time the name frictional electricity was given to a group of phenomena produced by electrical changes. This is an improper expression, because friction is only one means for producing electrical changes."[4] Another says: "Static electricity is, however, a misnomer; it has no existence; all the phenomena are due to static strains, but there is always a gradual loss called leakage, which is, however, the current due to the actual conductivity of all circuits, and every motion set up by so-called static electricity implies a transfer of energy and action occurring in a field of force set up in the form of strains in the particular inductive circuit in which the motions occur.[5] A third objects to the word "tension" in respect to electricity, and points out that "all the phenomena observable in connection with so-called high-tension electricity may be produced by electricity

1. Paper read before the Society of Telegraph Engineers and Electricians, on May 14, by Andrew Jamieson, Principal, College of Science and Arts, Glasgow.

2. Communication faite à la Société internationale des électriciens, le 5 Novembre, 1884, par M. E. Hospitalier sur L'Unité de Définitions, Conventions, Notations, et Symboles Electriques (*vide Electricien*, 15 Décembre, 1884).

3. The term used by Faraday. (See "Experimental Researches," by Michael Faraday, p. 82, Art. 264.)

4. "Electrician's Pocket Book," by E. Hospitalier, p. 5.

5. "Electricity," second edition, by Sprague, p. 6, Art. 20.

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drawn from batteries or dynamos, if the electromotive force or difference of potential is sufficiently increased." Would not the term "electrostatics" be more suitable and comprehensive?[6]

2. The old nomenclature, "vitreous" and "resinous," as applied to substances which, when rubbed by certain other substances, produce opposite electrical properties, and the scholastic one and two fluid theories, based upon these effects, should be discarded for the more comprehensive modern theory of electric polarity of molecules or continuous particles, expressed by "positive" and "negative," or by the algebraical signs, + and —.

3. "Electrics," "dielectrics," "non-conductors," "insulators," and "isolators" are terms used by different writers to express a condition or behavior of certain materials with respect to electricity, in contradistinction to the terms "non-electrics" or "conductors," as applied to other materials. The words "electrics," "non-conductors," and "non-electrics" are, strictly speaking, meaningless, because all materials may be termed electrics and all conductors, only differing in degree. The words "isolators" and "isolation" (from the French verb *isoler*, to isolate or separate) should give way to "insulators" and "insulation," as applied to substances which offer a comparatively greater resistance to electricity than semi or good conductors used in connection with the apparatus being referred to at the time.

The term "dielectric"[7] was first used by Faraday on finding that conduction was effected by induction (of polarity from molecule to molecule), and is generally employed by practical electricians when speaking of the inductive capacity of the insulating material surrounding the conductor of leading wires or submarine cables, or that placed between the plates of a condenser. In this sense, viz., of a body transmitting electric induction, or capable of undergoing electric stress, and retaining the stressed condition, it is a very appropriate term to use.

4. The term "accumulator" is the name given in several text-books to apparatus, such as the Leyden jar or condenser, for receiving and retaining quantities of electricity, but has been lately inappropriately applied to secondary batteries, which do not accumulate electricity.

5. "Cascade," as applied to Leyden jars, should give way to "series."

6. "Tension,"[8] "potential," and "electromotive force" are terms which, when variously and indiscriminately applied, have given rise to considerable confusion and a great deal of writing in trying to define them. If we consider "tension" as simply the stress put upon the circuit by the electromotive force, and not in the sense that it used to be employed (for example: "Join up a battery or set of condensers for tension"), it might do very well if kept in its place; but it can easily be dispensed with. "Potential" is a word that has also given great trouble. We find in "Sprague's Electricity"[9] no less than three pages devoted to an explanation of the different ways in which the words "tension" and "potential" are employed. Clerk Maxwell said: "The theory of electro-statics is greatly simplified by the introduction of this new conception of potential." "As soon as we pass from electrostatics to other departments of electrical science, we find that the conception of potential is no longer available, except when used in a restricted sense and under carefully-defined conditions." "In other parts of electrical science we have to deal with electromotive force in cases where 'potential' and consequential 'potential difference' are words without meaning." Professor Fleeming Jenkin, in his well-known text-book on electricity and magnetism, devotes 26 pages to "potential," and defines "unit difference of potential or electromotive force in electrostatic measure to exist between two points when the unit quantity of electricity, in passing from one to the other, will do the unit amount of work." "The property of producing a difference of potential may be said to be due to a peculiar force, to which force the name *electromotive force* is given." "The words *electromotive force* and *difference of potential* are used frequently one for the other, but they are not, strictly speaking, identical." "Electromotive force is the more general term of the two, and includes difference of potential as one of its forms." "Potential" might well be reserved for electrostatics, and "electromotive force" for electro-kinematics, or current electricity, and thus prevent confusion. The word "electric-pressure" has come into vogue lately, and strongly appeals to those of a mechanical turn of mind, seeing that the hydraulic simile of "head" or "pressure" is often brought forward to assist in explaining the terms "potential" and "electromotive force."

7. In magnetism we find the same want of uniformity exists. Take the case of a freely-suspended magnetized needle. The pole which turns towards the geographical north is variously called the "austral pole," "north pole," "north-seeking pole," "marked pole," and is painted red by Sir William Thomson, while Sir Wm. George Airy, Professor Guthrie, and others paint it blue. It is sometimes indicated by French makers by the letter A, and by British by the letter N. The pole which turns towards the geographical south is correspondingly called the "boreal pole," "south pole," "south-seeking pole," "non-marked pole," painted blue by Thomson, and red by Airy, Guthrie, and others, and indicated by the letters B or S. Such is the general doubt and diversity in regard to the nomenclature on this subject, that each author on magnetism considers it necessary to state at the outset which term and symbol he intends to apply. If once for all the pole which turns towards the north was termed the "*north* pole," painted red, and indicated by the letter N, and the opposite pole was termed the "*south* pole," painted blue, and indicated by the letter S, much vexation would be saved. The French terms "austral" and "boreal," with letters A and B, should be obliterated. In this way the earth would have a uniformly recognized polarity, which would of course be opposite to that of the magnetized needle—in other words, the true north pole of the earth would be that situated near the geographical south pole.[10]

8. Sailors and some writers on the mariner's compass call the angle which the magnetic meridian makes with the geographical meridian the "variation" of the compass, while electricians call it the "declination." Variation is, properly speaking, the hourly, diurnal, annual, or secular changes which occur in the value of the elements of terrestrial magnetism. This leads to great confusion and argument between the electricians and the officers of a telegraph steamer. The declination for each place is marked on the Admiralty charts. Sailors also speak of the "deviation" of a compass, meaning by that the local error due to the resultant of the quadrantal, semicircular, and heeling errors. It would be far better if they simply spoke of the "compass error," or angle which the meridian of their compass-needle makes with the true north and south magnetic bearings. This deviation or compass error arises from local magnetic influences on board ship. Sir William Thomson's well-known compass, when properly adjusted on board a ship, has no compass error, and therefore the only thing to guard against and correct for in the steering of a ship is the declination of the place where the ship may be at the time of observation. Of course, if the magnetism of the ship changes in the slightest, due to a change of cargo or position thereof (if of iron or steel), or due to

6. "Electricity and Magnetism," by Clerk Maxwell, Vol. I., Part 1.

7. Faraday's "Experimental Researches," p. 364. "I use the word *dielectric* to express that substance through or across which the electric forces are acting." (See also pp. 537, 538.)

8. For a good definition of these terms, see "Electricity and Magnetism," by Clerk Maxwell, Vol. I., p. 49.

9. 1884, edition, pp. 58-62.

10. Sir W. Thomson calls the magnetic pole of the earth, situated near the geographical north, the "north pole," and the end of the magnetized needle which points towards it the "*true south pole*" of the needle, and paints it red.

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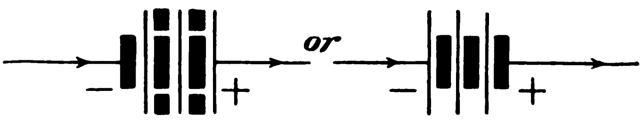
buffeting the waves for some time on one course, a slight error will creep in, but the compass can be soon adjusted to the new condition of affairs, and the officers have therefore seldom to think of or even speak of "deviation" or compass "error."

9. When we come to electricity generated by batteries, we find the expressions "galvanism," "voltaic electricity," "dynamic electricity," "electro-kinetics," "current electricity,"[11] etc., according to the fancy of the writer or speaker. Surely one name might suffice; and certainly the older terms "galvanism" and "voltaic electricity" might well be left to the past. The simple term "current electricity" seems to commend itself, as most of the effects in connection with this branch of the subject have reference to electricity as if it was in motion or distributing itself over a conductor.

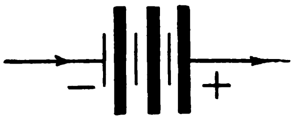
10. "Density of current" and "intensity of current" often cause great confusion. "Density of current" should only be used in the case of electrolysis or electro-deposition of metals. Here it means the ampères per unit of surface of the cathode. In electrostatics "surface density" or "electric density" means the quantity per unit area of surface. "Intensity" was used at one time in the same sense as "electromotive force" is now, and therefore not so much out of place there; but several writers, notably Professor Silvanus Thompson, have thought fit to borrow the French term "*intensité de courant*" wholesale, instead of a translation thereof, and symbolize it by the letter I. The literal translation of the French word *intensité* being strength or amount, therefore the expression "current strength," or simply "current," symbolized by C, is far preferable, for it conveys the correct meaning of the quantity in a given time. With a little pressure, French electricians would no doubt agree to the symbol C instead of I, to promote uniformity. Then I might be reserved for intensity of magnetism, where it suits very well.

11. "Positive electrode" "(+) terminal," "zincode," "anode," "positive pole," and "negative plate," severally used by different writers to designate that end of a cell, battery, or pile where the current leaves, and "negative electrode," "(—) terminal," "platinode," "kathode" or "cathode," "negative pole," "chlorous pole," "positive plate," where the current returns to or enters the same, requires revising and simplifying, more especially when we consider that the end plates of a battery are of opposite sign to their electrodes or terminals, and that the nomenclature is still further complicated when we come to consider secondary batteries or electrolysis by the terms "anion," "kation" or "cation," and "ions. Take, for example, the definition given by Sprague[12] of "anode": "The positive electrode or pole of a battery; the wire or plate connected to the copper or other negative element of the battery; the plate which leads the + current into a solution to be decomposed, and at which are set free the oxygen, acid radicals and all —ions (anions). In electrometallurgy it is usually formed of the metal to be deposited, in which case it is called the soluble anode or pole."[13]

12. Again, we have the two different ways of graphically representing a battery according to the whim or fancy of the writer. Practical submarine electricians were the first



to use this very neat and handy way of representing a battery and its poles, and always adopted the former method with the long thin vertical line for the plate where the current leaves, and the thick short line for the plate where the current returns to the battery. Why should this have been departed from? It is a mere arbitrary arrangement, but, being a most convenient symbol, it should be used in a uniform manner. Mr. John Munro proposes that the symbol for a secondary battery should be a modification of this, viz.:



the current outside the cell proceeding from the long line to the short one.

13. "Parallel circuit," "multiple arc," "loop circuit," "in loop," "derived circuit," "shunt circuit," are all expressions to signify much the same thing, where one expression, "shunt circuit," would do.

14. "Polarization" is a term used in many different senses—for example, the polarization of battery plates, molecular polarization due to electrification or magnetization, polarization of light due to magnetism, etc., as in Dr. Kerr's experiments. Some reform is required here.

15. Coming to telegraphy, telephony, and electric lighting, we find, as M. Hospitalier points out, "the words generator, receiver, transmitter, and motor are mixed up by different inventors, sometimes through ignorance, sometimes willingly." "A generator is an apparatus which, receiving energy of a certain nature, produces an energy of another nature, and it borrows its name from the nature of the energy which it generates. A receiver is an apparatus analagous to the generator, but it borrows its name from the energy which it receives." "A given apparatus is at once a generator and receiver—for example, an electric motor is a generator of mechanical energy and a receiver of electrical energy." "The name transmitter ought to be reserved for an apparatus which, receiving an energy of a certain kind, produces or brings into play an energy of the same kind or of the same form." For example, a relay on a telegraph system, or induction coils as used on a trunk telephone line with several subscribers' lines at each end, or in electric lighting on the Gaulard and Gibbs system, lately tried in London. Professor Silvanus Thompson uses the phrase "dynamo-electric machinery" in the most general etymological sense of the term, as meaning machinery for converting the energy of mechanical motion into the energy of electrical currents, or *vice versâ*, excepting such induction machines as Holtz, Voss, etc. He thinks this reduces the ambiguity to a minimum, and leaves the word "motor" to be applied, if desired, to the steam-engine, water-wheel, etc., from which the mechanical motion is derived. The terms "magneto-electric machine," as applied to a dynamo fitted with permanent field magnets, and "electro-magnetic machine" to a series, separately excited, shunt, or compound-wound dynamo (generator or receiver), are very handy expressions, and should not be discarded.

16. We have dealt hitherto chiefly with definitions and nomenclature, and have given a few examples; others will occur to every member present. We now come to abbreviations and notation with symbols. The want of uniformity here, and the need for systematizing is still more obvious, but perhaps more difficult to accomplish. Every one admits the great advantage in being able to write down the symbols for chemical elements and their actions and reactions one with the other in the form of simple equations, which any one may comprehend who knows the subject, without a detailed description of what each letter or symbol stands for. Electricians should not rest satisfied until they are supplied with a similar universally-accepted notation, whereby electrical phenomena and actions may

11. See Ferguson's "Electricity," second edition, by Professor Blyth, p. 164. The term "electro-kinematics" has been used by Clerk Maxwell to cover a large part of this subject, such as "electric current," "conduction," "resistance," "electromotive force," "electrolysis," etc. (See "Electricity and Magnetism," by Clerk Maxwell, vol. I., part 2.)

12. Sprague's "Electricity," 1884 edition, p. 624.

13. See Faraday's "Experimental Researches," articles 661 to 687, on *Definitions of New Terms*, where he very clearly points out the meaning he attaches to the words "electrode," "anode," "cathode," "ions," "anion," "cation," etc.

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be similarly treated. The author submits a sample of what he considers would be useful in this respect. Many of them are taken from Munro and Jamieson's "Pocket-book of Electrical Formulæ," where an effort was made to use the same notation and abbreviations throughout, except in such cases as that of quoting direct from some other author.

It will be observed in this list that in most cases the first English or Greek letter of the word has been used. Those relating to the metric system have been copied from the French edition of Hospitalier's "Electrician's Pocket-book," which are no doubt copied from the list decided upon by the international commission on the metre, with a few omissions and additions by the author.

The Greek letters π, μ, ε are universally adopted—π for the ratio of the circumference of a circle to its diameter, μ for the coefficient of friction, and ε for the base of Naperian logarithms.

METRIC ABBREVIATIONS.

m.	for	metre.
cm.	"	centimetre.
mm.	"	millimetre.
m.q.	"	metre-square.
m.c.	"	metre-cube.
c.q.	"	centimetre-square.
c.c.	"	centimetre-cube.
gm.	"	gramme.
mg.	"	milligramme.
k.g.	"	kilogramme.
kgm.	"	kilogrammetre.
&c.		&c.
temp.	"	temperature.
res.	"	resistance.
g.d.	"	gramme-degree.
kg.d.	"	kilogramme-degree.

ELECTRICAL ABBREVIATIONS, NOTATION, AND SYMBOLS.

When a capital letter is used for the symbol, then small capitals or italics with suffixes, 1, 2, 3, &c., may be used for parts making up a whole. For example—L for length, L_1, L_2, L_3, &c., or l_1, l_2, l_3, for different lengths or parts of L.

FUNDAMENTAL AND DERIVED MECHANICAL UNITS.

L	for	Length.
M	"	Mass.
T	"	Time.
V or v	"	Velocity.
A or a	"	Acceleration.
F	"	Force.
δ	"	dyne; *e. g.*, 10 δ = 10 dynes.
W	"	Work.
w	"	weight.
ft. lb.	"	foot pound.
H. P. or HP	"	Horse-power.
I. H. P.	"	Indicated horse-power.
B. H. P.	"	Brake horse-power.

OTHER COMMON SYMBOLS, ALLIED TO MECHANICAL WORK.

S	for	Speed or stress.
D or d	"	Diameter.
r	"	radius.
ω	"	angular velocity = $2\pi n$ in radians per second.
g	"	acceleration due to gravity.
N or n_1 n_2, &c.	"	number of revolutions.
—'	"	second; *e. g.*, $3^{hr}\ 5^{m}\ 10^{s}$ = 3 hours 5 minutes 10 seconds.
$\tau_1 \tau_2 \tau_3$, &c.	"	temperatures, absolute.
or $t_1°t_2°t_3°$, &c.	"	" common.

PRACTICAL ELECTRIC CURRENTS.

The astronomical method of putting the small letters above the line of the figures, as in the case of the example $3^{hr}\ 5^{m}\ 10^{s}$ (3 hours 5 minutes 10 seconds), has not been followed in the following examples, as mathematicians object to the system, the letters appearing as if they were powers. Neither will they readily agree to suffixes, as suffixes have been already adopted by them to distinguish between things of the same kind. The author has therefore written the distinguishing letters on a level with the figures: for example, 10ω stands for 10 ohms (the methods 10^{ω} and 10_{ω} being both objectionable).

C. G. S.	for	centimetre, gramme, second.
R	"	Resistance.
ρ	"	specific resistance.
ω	"	ohm; *e. g.*, 10ω = 10 ohms.
Ω	"	megohm; *e. g.*, 10Ω = 10 megohms.
C	"	Current.
A	"	ampères; *e. g.*, 10A = 10 ampères.
a	"	milliampères; *e. g.*, 10a = 10 milliampères.
E	"	Electromotive force or E. M. F.
v	"	Volts; *e. g.*, 10v = 10 volts.
K	"	Capacity.
σ	"	specific inductive capacity.
Φ	"	farads; *e. g.*, 10Φ = 10 farads.
φ	"	microfarads; *e. g.*, 10φ = 10 microfarads.
Q	"	Quantity (coulombs).
P	"	Power.
W*P*	"	Watts or Watt power.[14]
W	"	Work in Joules.
H	"	Heat in "
J	"	Joule's equivalent = 42×10^6 ergs, or work spent on ·2405 gm. of H_2O raised by 1° cent.

$$C = \frac{E}{R} \text{ (Ohm's law).}$$

$$E \times C = C^2 R = \frac{E^2}{R} = WP \text{ (Watt powers).}$$

$$E\,C\,T = C^2 R T = \frac{E^2 T}{R} = E\,Q = W \text{ (Joules).}$$

$$\frac{E\,C\,T}{J} = \frac{C\,R\,T}{J} = \frac{E^2 T}{J R} = \frac{E\,Q}{J} = \frac{W}{J}$$

$$= W \times \cdot 2405 = \text{g. d. or gramme degrees.}$$

z = Electro-chemical equivalent.

MAGNETISM.

N	for	North pole of a magnet, painted red.
S	"	South " " painted blue.
m	"	magnet strength (of pole) or quantity of magnetism.
l	"	distance between the poles of a magnet.
M or ml	"	moment of a magnet.
$\mathfrak{I}$ or I	"	intensity of magnetization.
s	"	cross section of a magnet.
mp	"	magnetic potential.
μ	"	magnetic permeability.
$\varkappa$	"	magnetic susceptibility.
H	"	horizontal intensity of terrestrial magnetism.
θ	"	angle of deflection.
d_1 d_2 d_3	"	divisions deflection, as in mirror galvanometer.
r	"	radius (mean) of a coil or solenoid.
n	"	number of anything; *e. g.*, turns of wire in a coil of galvanometer.

Take tangent galvanometer formulæ as an example to illustrate the above :

$$\text{Current, } C = H \frac{r}{2\pi n} \cdot \tan\theta$$

14. By adopting the term "Watt power," there can be no doubt what a Watt means.

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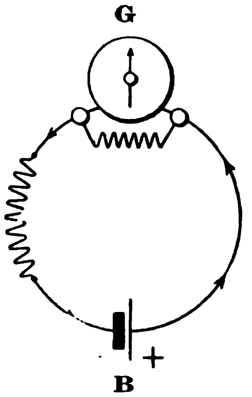
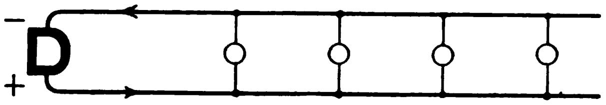
G for Galvanometer or galv. res.
s " shunt res. for galvanometer
r " resistance coils
B " Battery or battery res.

$$\therefore R = B + \frac{G\,S^1}{G+S} + r$$ [15]



DYNAMO CIRCUITS CONTRACTIONS.

Example :



D for Dynamo.
T+ " Terminal positive.
T— " Terminal negative.
E. M. " Electro-magnet.
or F M. " Field magnet.
c. p. " candle-power of a lamp.
A. M. " Ampère-metre.
V. M. " Volt-metre.
S. W. G. " Standard wire gauge.

FOR USE IN FORMULÆ.

R_a R_m R_e for Resistance of armature, magnets, and external circuit respectively.
C_a C_m C_e " Current in armature, magnets, and external circuit respectively.
L_s " coefficient of self-induction.
L_m " coefficient of mutual induction.

In the above notation the first letter of the most important words has been used wherever it was found practicable to do so, and the recurrence of the same letter under similar circumstances avoided as much as possible. In cases where no ambiguity can occur, such as H for the heat in Joules, and H for the horizontal intensity of the terrestrial magnetism; *m* for metre, and *m* for magnetic strength of pole; V for velocity, and v for volts, it will be observed that the same letters appear in each case.

A discussion followed the reading of the above paper, M. Hospitalier, who had come from Paris for the express purpose, leading off with a series of sharp criticisms on Mr. Jamieson's proposals. M. Hospitalier stated that the committee in Paris had already made some progress in devising a scheme of notation and nomenclature such as might form the basis of an international system. Nothing of the kind could be expected of Mr. Jamieson's scheme, which proceeded on no definite principles, and was often contradictory, arbitrary, and hard to remember. Professor Forbes, Professor Aryton, and others followed, their general verdict being unfavorable to Mr. Jamieson's paper. The president, Mr. Spagnoletti, announced that the society had had under its consideration the desirability of arriving at some international understanding on this subject, and had that evening decided to form a committee for its investigation. The committee in the first instance would be a broad one, and not confined to members of the society.

15. See Munro and Jamieson's "Electrical Pocket-book," p. 65.

THE CALORIMETRIC MEASUREMENT OF INCANDESCENT LAMPS.[1]

BY WILHELM PEUKERT.

An important advantage of the electric light as compared with other systems of illumination, lies in the relatively far smaller amount of heat developed by the former for an equal intensity of light. Accurate calorimetric measurements of incandescent lamps have not yet been made public, and the results obtained with such lamps are therefore given below, whilst I reserve for a future occasion a report on corresponding experiments with arc lamps. The experiments may be of interest from another point of view, as they enable us to form a conclusion as to the economical utilization of the electric energy consumed by a lamp. The working of a lamp, other circumstances being equal, must be considered the more rational the greater the proportion of the electric energy absorbed which re-appears in the amount of light generated.

The experiments have been conducted in the electrotechnical laboratory of the Technical High School at Hanover, and it is my pleasant duty to put on record my obligation to Prof. Dr. W. Kohlrausch, who placed at my disposal the necessary apparatus, as well as to Herren Caspari and Ottesen, who took part in the measurements.

The determination of the heat evolved by the incandescent lamps was effected by means of a calorimeter. This consisted of a large beaker of thin glass, which was filled each time with a quantity of water carefully weighed.

The incandescent lamp in question was immersed in the water, which was continually kept well mixed by means of a simple agitator, and possessed a uniform temperature. This temperature was observed on a thermometer placed in the calorimeter, graduated in tenths of a degree centigrade. The calorimeter was fixed on a heat insulator, and to avoid as far as possible losses of heat to the surrounding air, a very slight difference between the respective temperatures of the air and the water was maintained during the experiments, amounting to 5° C. in one case only, and being in others always below this maximum value. That, in fact, the increase in the temperature of the water was little affected by the temperature of the air, is shown by the following rises of temperature taken at equal intervals of time, which in few cases differ by 0.1° C. The temperature of the work room increased only by 1° C. during the entire time of the investigation.

To ascertain the absorption of light, every lamp was determined photometrically, both when exposed freely and when placed in the calorimeter. As a standard of comparison, I used Von Hefner-Alteneck's normal flame. The current was furnished by a Schuckert's compound machine driven by a well-regulated Otto gas engine, so that the potential difference at the lamps, measured with a Siemens and Halske torsion-galvanometer, remained very constant. The strength of the current was determined with the same instrument by ascertaining the difference of potential at the ends of an accurately known resistance.

The results obtained are as follows:

SIEMENS AND HALSKE INCANDESCENT LAMP.

The lamp worked with a potential difference of 98 volts and a strength of current of 0·554 ampère, which values were found as the mean of all the observations executed simultaneously, which, as already mentioned, differed little from each other.

The calorimeter contained 2,471 grms. water, and if we calculate the value of the vessel in water as 79·1, the total quantity of water was 2,550·1 grms.

The observations were made at intervals of three minutes.

1. *Zeitschrift für Elektrotechnik.*

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This rise of temperature of 0.7° in three minutes gives an hourly development of heat of 35.7 kilogram calories.

Thermometer.	Rise of Temperature.
14·9°	0·6°
15·5°	0·7°
16·2°	0·8°
17·0°	0·7°
17·7°	0·7°
18·4°	Mean 0·7°

The lamp when burning freely gave a light of 8·8 normal candles, and when in the calorimeter, 8·1.

EDISON'S INCANDESCENT LAMP.

Potential difference at the lamp = 93·6 volts; strength of current = 0·963 ampère.

Total quantity of water, 2,791·1 grms.

Observations at intervals of five minutes.

Thermometer.	Rise of Temperature.
14·65°	1·65°
16· 3°	1· 7°
18· 0°	1· 6°
19· 6°	1· 7°
21· 3°	1· 6°
22· 9°	Mean 1·65°

The rise of temperature of 1·65° in five minutes gives an hourly development of heat of 55·26 kilogram calories.

The lamp, burning free, gave a light of 16·9 normal candles, and in the calorimeter 14·4 normal candles.

SWAN'S INCANDESCENT LAMP.

Potential difference = 76 volts; current = 2·552 ampères. Quantity of water, 2,435·1 grms. Observations every two minutes.

Thermometer.	Rise of Temperature.
15·1°	1·7°
16·8°	1·7°
18·5°	1·7°
20·2°	1·7°
21·9°	1·7°
23·6°	Mean 1·7°

A rise of temperature of 1·7° in two minutes represents an hourly development of heat of 124·19 kilogram calories. The lamp, burning free, gave a light of 30 normal candles; in the calorimeter, of 28·2 normal candles.

BERNSTEIN'S INCANDESCENT LAMP.

Potential difference = 48 volts; current = 3·934 ampères. Total quantity of water, 2425·1 grms. The observations were made at intervals of two minutes.

Thermometer.	Rise of Temperature.
15·5°	1·1°
16·6°	1·1°
17·7°	1·1°
18·8°	1·1°
19·9°	1·1°
21·0°	Mean 1·1°

The rise of temperature of 1·1° in two minutes gives an hourly development of heat of 80·03 kilogram calories.

The lamp, burning free, gave a light of 52·1 normal candles, and in the calorimeter 51 normal candles.

Concerning this lamp, it must be remarked that the quantity of heat as determined is possibly too low, since losses of heat were not absolutely excluded in the experiment, owing to the construction of the lamp, which could not be entirely immersed in the water.

As the electric energy consumed by an incandescent lamp is converted into heat and light only, the portion of the total work of the current equivalent to the light evolved may be determined approximately, if not with absolute accuracy. An experiment may here be mentioned which was performed with an Edison A lamp.

It was placed in the calorimeter along with a vessel of thin sheet copper, so that light and heat were kept back. The amount of heat determined in this case agreed to two per cent. with that calculated from the potential difference and the strength of the current.

If we may assume that in the first-mentioned experiments the entire heat developed was absorbed by the calorimeter, and that the heat lost in the air was but small, which approximately speaking was the case, we obtain for the quantities of light evolved by the various lamps the following equivalent quantities of heat:

SIEMENS AND HALSKE'S LAMP.

	Kilog. calories.
Hourly quantity of heat corresponding to the work of the current	46·98
Heat equivalent to the light evolved	11·28
Hourly heat per normal candle	1·393

Consequently for this lamp, with reference to the absorption of light, the heat evolved hourly may be estimated at 37·73 kilogram calories, corresponding to 74 per cent. of the total work of the current, so that 26 per cent. of the current falls to the quantity of light evolved.

EDISON'S LAMP.

	Heat units.
Hourly amount of heat corresponding to the work of the current	78·01
Heat equivalent to light evolved	22·75
For normal candle hourly	1·58

Thus the heat evolved hourly by this lamp may be taken as 51·31 heat units. Hence 66 per cent. of the work of the current are expended in heat and 34 per cent. in light.

SWAN'S LAMP.

	Heat units.
Hourly amount of heat representing work of current	167·86
Heat equivalent to light evolved	43·67
Therefore for a normal candle hourly	1·549

The heat evolved by this lamp hourly is 121·4 heat units. Hence 72 per cent. are expended in heat and 28 per cent. in light.

BERNSTEIN'S LAMP.

	Heat units.
Hourly amount of heat representing work of current	163·43
Heat equivalent to light evolved	83·4
Therefore hourly per normal candle	1·635

The hourly heat for the lamp is therefore 78·24 heat units. Of the total work of the current, 48 per cent. is expended in heat and 52 in light. This high percentage may be due to the circumstance that, as already mentioned in the experiments with this lamp, considerable losses of heat were not excluded. Indeed, the percentages of the work of the current assigned here to the production of light can only be regarded as the superior limit. Experiments more precise than those here described may possibly yield lower values.

If the hourly quantities of heat per unit of light are calculated into their equivalents of mechanical work, we obtain the mechanical work per second equivalent to a unit of light (and therefore for a magnitude which may be regarded as the mechanical equivalent of this light), the following values: 0·16 kilogrammetres (Siemens and Halske), 0.18 (Edison), 0·18 (Swan), and 0·19 (Bernstein). These values show a sufficient agreement for the experiments just described, but can by no means be regarded as giving an accurate value for the mechanical equivalent of light. Indeed, the experiments were not conducted with any such intention. These results are merely mentioned here as a

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corollary of the experimental conclusions, perhaps not quite devoid of interest.

For the sake of comparison, the amounts of heat obtained with other sources of light are tabulated along with those found with incandescent lamps. The hourly quantities of heat evolved are:

	Heat units.
Incandescent lamps. Siemens and Halske	427
" " Edison	355
" " Swan	430
" " Bernstein	153
Gas. Siemens' regenerative burner	1,500
" Argand	4,860
" Two-hole burner	12,150
Petroleum. Round burner	3,360
" Small flat burner	7,200
Solar oil. Schuster & Bauer's lamp	3,360
" " Small flat burner	7,200
Rape oil. Carcel lamp	4,200
" " Reading lamp	6,800
Parafiine candles	9,200
Spermaceti candles	7,960
Wax candles	7,960
Stearine candles	8,940
Tallow candles	9,700

The above mentioned experiments have led me to undertake a close investigation into the conversion of electric energy into light and heat, both in incandescent lamps and arc lamps. A memoir on this subject will shortly appear.

INCANDESCENT LAMP ECONOMY.

BY W. D. WEAVER,

(Assistant Engineer United States Navy.)

In an article[1] that appeared under the above caption in the columns of the April number of THE ELECTRICIAN AND ELECTRICAL ENGINEER, the writer gave a formula and its deduction showing the relation between the life of an incandescent lamp, its cost, the cost of the energy transformed and the resulting candle power.

The formula given was

$$y = \frac{b}{l\,x} + \frac{a\,k_1\,x^{\frac{1}{n}}}{746\,x} \qquad (1)$$

where y=total hourly cost of unit light.
a=total hourly cost of one electrical h.p. delivered at the lamp.
b=cost of lamp.
l=life of lamp.
k=constant of given lamp.
x=c. p. of lamp.

From the most reliable experiments then available, a numerical value of 2.7 was deduced for n. Subsequently, however, from more reliable and satisfactory experiments, a somewhat higher value for n has been deduced, and this value, 2.85, is probably very nearly correct.

In the same paper it was shown that if a relation could be established between the c. p. of a lamp and its resulting life, a value may be deduced for a c. p. at which the cost of the light will be a minimum, and the equation $l = k\,(m-x)^n$ was suggested as being likely to express this relation.

Since the appearance of the paper, there has been communicated to the writer the result of elaborate sets of experiments to obtain this relation. Calling l the life of a lamp at its normal c. p., C, and l' its life at any other c. p., C', it was found that the relation, $\frac{l'}{l} = \left(\frac{C}{C'}\right)^{3.65}$ holds true "for even the widest ranges of c. p."

As l and C are constants, the formula may be expressed, using the same notation as in formula (1) $l = \frac{k_2}{x^{3.65}}$ (2). By substituting l in (2) for l in (1) and differentiating, a value of x will be obtained at which the cost of the unit light will be a minimum; in order to make the solution more general, let $3.65 = m$ so that (2) will be $l = \frac{k_2}{x^m}$.

Substituting in (1)

$$y = \frac{b\,x^m}{k_2\,x} + \frac{a\,k_1\,x^{\frac{1}{n}}}{746\,x}$$

Reducing $y = \frac{b}{k_2}x^{m-1} + \frac{a\,k_1}{746}\,x^{\frac{1-n}{n}}$

Differentiating and placing $\frac{d\,y}{d\,x} = o$

$$\frac{d\,y}{d\,x} = \frac{(m-1)\,b}{k_2}x^{m-2} + \frac{(1-n)\,a\,k_1}{746\,n}x^{\frac{1-2n}{n}} = o.$$

Whence $x = \sqrt[\frac{m\,n-1}{n}]{\frac{a\,k_1\,k_2\,(n-1)}{746\,b\,n\,(m-1)}}$

Substituting for n and m their respective values, 2.85 and 3.65, and reducing, we have finally

$$x = .08734\ \sqrt[3.29]{\frac{a\,k_1\,k_2}{b}}$$

From the above equation, the following tables have been deduced. In the first table it is assumed that the life of a lamp at its normal (20) c. p. is 1,000 hours, and in the second table, 2,000 hours. The figures in the first column are the watts with which the unit light is produced at the normal c.p.; the cost of the hourly h.p. is given in the second column in cents, and is the entire cost of an electrical h.p. delivered at the lamp, interest on, and depreciation of plant being taken into consideration; the cost of a lamp is given in cents at the head, and the remaining figures are the respective candle powers at which the cost of the unit light under the conditions given is a minimum.

TABLE I.

Life at Normal C. P. (20)—1000.				
Efficiency of lamp.	Cost of hourly h.p.	Cost of Lamp.		
		50	75	100
2.5	4	21.9	19.8	17.7
	7	25.9	22.9	21
	10	28.9	25.6	23 4
3.5	4	24.3	21.5	19.6
	7	28.8	25.4	23.3
	10	32	28.3	27.2
4.5	4	26.2	23.2	21.2
	7	31	27.4	25.2
	10	34.6	30.5	28

TABLE II.

Life at Normal C. P. (20)—2000.				
Efficiency of lamp.	Cost of hourly h.p.	Cost of Lamp.		
		50	75	100
2.5	4	27	25.5	21.9
	7	32.1	28.8	25.9
	10	35.7	31.5	28.9
3.5	4	29.9	26.5	24.2
	7	35.5	31.4	28.8
	10	39.5	35	32
4.5	4	32.3	28.5	26.2
	7	38.3	33.9	31.1
	10	42.7	37.7	34.6

As the exponent, m=3.65, was determined for but one kind of lamp, it can only be provisionally accepted until experiments with other lamps have been made.

As the life of a lamp is also dependent upon the source of power, being much longer if fed from secondary batteries, it will be interesting to know if such variation will affect the exponent or only the constant.

Experiments in this direction will be of the greatest value, and if it is definitely proved that the life of a lamp varies according to an empirical law such as the one given, one of the most important problems in electric lighting will be solved. Thus, if the value of m given is nearly correct and general, it will be seen from the tables that in the majority of cases at the present time, lamps are used at too low candle powers.

1. Reprinted from Van Nostrand's *Engineering Magazine*.

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BOGUS TELEGRAPH SCHOOLS AND THEIR METHODS.[1]

Among the many traps for the unwary to be found in New York none is bolder or meaner than the bogus school for telegraph operators. In the columns of the daily papers advertisements like the following can be seen every day:

Wanted.—7 young men to learn telegraphy; salaries guaranteed when qualified—$45 to $125 monthly.

Wanted.—5 young gentlemen and 4 ladies to learn telegraphy; good positions, when competent, at salaries from $45 to $125 monthly; every graduate obtains a steady situation as soon as qualified.

The victims are always young people who have but little money, and who are ambitious to improve their positions in life. They are usually working girls who have to work ten hours a day in dusty shops for a pittance, but who, in the hopes of gaining a livelihood in more cheerful surroundings, starve and pinch themselves until they obtain the money necessary to pay the tuition fee of a schoolmaster who professes to teach telegraphy, and then rob themselves of needed sleep and rest in order to attend the school. After months of anxious labor they receive printed sheets of paper that are called diplomas, but when application is made for the "positions when competent at salaries from $45 to $125 a month," they find that the snapper of the whip is in the words "when qualified," and that no amount of instruction in the school could make them qualified. In other words, they have been deliberately deceived by the advertisements and circulars of the school, and the money which they saved by going without food has been taken without any return.

The advertisements are fraudulent in wording. They specify that five or seven young people are wanted, because the thoughtless are thereby led to think that these numbers are called for to fill definite vacancies. If the person who reads the advertisement answers it by letter he will receive in return a circular that is filled with statements invariably false or misleading. Thus the circular from a Broadway concern says:

We are often asked what is the probability of obtaining a position at the end of the term. We answer positively that any person having a knowledge of the business will surely obtain a position. Hundreds of our operators are now filling responsible positions both in the east and west.

Mr. J. B. Taltavall, the editor of the *Telegraphers' Advocate*, read that part of the circular, and said:

"A friend and I called at that place one day and had a talk with the assistant. The manager couldn't talk, because he was blind-drunk. 'How great a per cent. of your pupils really become operators after they leave you?' I asked. 'No per cent.,' he said. 'We never got a job for one of them. But we fill the contract; we can get them work if they ever become qualified.'"

"Was that true?" was asked of Mr. Taltavall.

"No it wasn't. They couldn't get a job for any one, because managers won't look at a school operator."

At the office of superintendent Humstone of the Western Union Telegraph Company, a young man was asked if a graduate of a telegraph school could obtain a job, provided there was a vacancy.

"We do not discriminate against those who attend the schools," he said. "We treat all applicants alike. If graduates, as you call them, go somewhere and learn the business after they leave the colleges, they stand as good a chance as anybody."

"But do they learn the business at the colleges?"

"They do not. It is utterly impossible. They learn the alphabet and nothing more. Learning to operate a telegraph instrument is something more than learning the alphabet. You might as well expect a man to make a revised translation of the Scriptures after learning the Greek alphabet as to expect him to get a job in this office after going through one of these schools. At the same time we favor one school to a certain extent, the one in Cooper Union. Girls can learn the rudiments there, and we occasionally take those that are most intelligent and place them in the forwarding offices, or the little places at street corners and ferries, where a dozen or two messages are sent in a day. There they have plenty of time to work out a message, and some of them become valuable operators. It takes years of practice to make an operator, though."

"These schools, in their advertisements, say that graduates can obtain employment where the pay runs from $45 to $125 a month. Are salaries as good as that?"

"There is not an operator in the country that makes such wages. There are plenty of operators working for $30, and there are instances where a few first-class cable men get as high as $90. The advertisements are frauds."

Edward E. Todd, an experienced operator, went around to several of the schools in this city to learn the actual value of the instruction given. The schools were in little 7 by 9 rooms, with tables placed around under signs marked "Chicago," "St. Louis," "Boston," etc. Girls outnumbered the young men very largely in the rooms. The students pounded the instruments in a way that set his teeth on edge, but the work of the instructors was about as bad. One boy with an impudent face said he had learned the business in three months, and was then made an instructor. The operator, who was standing near a table, touched a key, making a meaningless sound.

"Ha!" said the boy, "do you know what you made? It was the word 'the.'"

"Make it again," said the operator.

The boy rattled off t-p-e, and then confidentially remarked that there was no business in the world that was so easy to learn, or so fascinating to those who had learned it, as telegraphing. One school advertised its long-wire service, which consisted of a wire running for two blocks over the houses. The instructor represented that practice over this wire would enable the students to acquire the proficiency necessary to operate Chicago or St. Louis lines. As a matter of fact, the wire was no better than if it had been ten feet long, and if it had been ten miles it would have been equally worthless for instruction in long-wire practice.

This operator found that the managers of the schools did not hesitate to forge names to their certificates of good character. One manager, with whom the operator was acquainted, had formerly been employed regularly in this vicinity, and when he opened his school got his acquaintances to sign letters of recommendation, which he afterward used as testimonials for the school. In some instances letters have been printed that were never written by the people whose names were signed. One manager had to be threatened with prosecution for forgery by an operator whose name had been used.

"Do the schools never graduate a pupil who eventually becomes an operator?" was asked of editor Taltavall.

"Now and then a student is particularly ambitious, and is naturally adapted to the business. If he has enough money he may learn the business. The manager, after graduating the youngster, offers the manager of some office a fee to give the pupil a chance to learn. Not long ago one of these schools had printed in the Western Union organ a standing offer of $10 to any manager who would allow the pupil to hang around his office and do such work as he could. Of course the work was to be done without compensation, and the pupil had to put up the $10. Some managers took it up; they kept the pupil around for a week or two, and then kicked him out to make room for another pupil with the $10 bonus. The treatment of these ambitious young people is shameful. Even where the graduate is apt he finds, when he has paid his bonus and has gone to work in a regular office, that he has first to unlearn all that he learned in the school. His time and

1. New York *Sun*.

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money spent in the school were worse than wasted; but if he has the pluck he can still learn the business. A great many boys and girls come in from the country to learn the business. Schools are sometimes established in small provincial cities for the benefit of rural greenhorns. I have exposed a number in the *Advocate*, but only operators read the paper, and so the exposure does no real good. The instructors say the *Advocate* opposes the school because the Telegraphers' Brotherhood wishes to limit the number of operators. The fact is, the schools help to limit the number of operators by disgusting young men and women who would otherwise learn the business in some office where practical work was done.

"There is another feature of these schools which ought to be mentioned, and that is their moral influence on young girls. The schools are located on top floors and in back rooms, and designing men have every advantage. In fact the assistant manager on whom I called with a friend, as you have already written, boasted of his crimes against virtue."

The prices charged vary. One circular puts the price at, "per term of three months, $35—$15 upon entering and $10 per month thereafter until the full amount is paid, or $30 if all paid in advance. The instruction lasts twelve hours a day, ending at 9½ at night." Another circular, under the head of "extra inducement," says: "We will make the scholar a proficient operator for the sum of $25, in advance." This same circular says, under the head of "time in learning," that "four hours a day, from four to five months of close application, will be found sufficient time for all persons of ordinary ability."

Careful inquiry at the time of the strike of the telegraphers showed that there were plenty of operators waiting for vacancies, while the number now unemployed and waiting for an opening is probably much greater than the number actually employed. Even if the schools gave valuable instruction, and work could be obtained at once, telegraphing would not be a desirable business to learn; the pay of the skilled operators is not as high as that of many mechanics of corresponding ability, while clerks or expert bookkeepers make better wages. The work seems to be easy to those who have never done it, but it is, in fact, very hard, and wears out the operator rapidly, as many a man, gray before his time, is willing to testify. Another objection to the work is that there are but two telegraph companies, and these may be consolidated at any time. While men can only make $15 a week working for them, they are liable to lose even that if they displease the one boss who rules them. A discharged operator may get work on a railroad, but the pay runs from $7.50 to $10 a week in the country, wages which even the cloakmakers in the east-side tenements refuse to accept.

LAWS OF THE CHARGE AND DISCHARGE OF ACCUMULATORS.[1]

In a preceding article we described the methods followed by Messrs. Crova and Garbe for observing and registering the phenomena attending the charge and discharge of accumulators. These results, obtained by the method of registration, are most interesting, and form the subject of a communication presented, on behalf of the experimenters, to the Academy of Sciences recently by M. Faye.

It will be remembered that the accumulators used were those of M. Planté, perfected by M. Faure; each of them was formed of 12 plates of 1.1 d.m.q. (4.3 square inches) on each face, equivalent to an active surface of 26.4 d.m.q. (103.2 square inches) at each pole.

1st. *Phenomena of charge.* The quantity of the charging current being considerable (12 ampères), the weight of the plates diminishes rapidly, but a liberation of gas from their surfaces takes place at the end of three hours; this liberation does not indicate that the accumulator is saturated, for the inclined right line which defines the rule of charge[2] begins then to bend by turning its concavity towards the axis to which it tends to become parallel; it then becomes wavy on account of the liberation of gas which causes the balance to oscillate gently, and at the end of a sufficient time (about eight hours), it becomes straight and parallel to the axis, thus indicating the limit of charge; the total diminution in weight for the whole charge being 148 grammes (about .02 oz avoirdupois). In proportion as the charging current is feeble, the later does the liberation of gas appear; with a constant charge of three ampères, it is only manifested when the total charge is acquired.

The liberation of gas should be avoided as much as possible; in fact it shows a loss of energy not absorbed, and contributes to the disintegration of the active layer; when this occurs brown and gray flakes of bi-oxyd and of sulphate are seen to become detached from the plates and fall to the bottom of the cell.

The quantity of the charging current ought not then to exceed a certain limit, which is that under which the liberation of gas is only manifested when the plates are saturated; that is, when they cease to diminish in weight.

2d. *Phenomena of discharge.* The accumulator being closed on a known resistance, the law of uniform delivery begins almost instantaneously; the quantity hardly varies at the start and rapidly attains a remarkable constancy; the register then traces a straight line which is more inclined over the axis of the abscissæ in proportion as the delivery is greater.

At the end of a time varying with the quantity of current discharged the straight line bends rapidly; the delivery diminishes suddenly and the accumulator traces a line much less inclined, which ends by degenerating into a very long curve tending to become a straight line parallel to the axis of the abscissæ, the exhaustion is then nearly complete.

The second condition, that of feeble and variable discharge represents a fraction, practically wasted, of the charge. As the quantity of the current of discharge is greater, so is the straight line, which represents the practically useful and constant discharge, inclined and short; the longer also is the duration of the residual discharge corresponding to a feeble potential; after a powerful discharge of 8.4 ampères, having lasted only 3 hours, the condition of feeble discharge has lasted 115 hours and represented ⅝ of the total charge, only ⅜ of the total charge being utilized. In these cases it is necessary to re-charge the accumulators in order to saturate them anew, without trying to use the residual charge; but then it appears as though the capacity of the accumulator was reduced to a fraction as much more feeble as the quantity of the current of discharge is more considerable. The feebler the current of discharge the more the constant condition is prolonged; with a current of 3 ampères we have had a constant delivery during more than 15 hours; in this case the fraction of the charge utilized was ⅘ of the total charge; with a smaller delivery still, the useful return would be still greater.

During the intense discharge the chemical action is localized on the portions of the active layer immediately in contact with the lead; if the current of discharge is feeble, the chemical action tends to equalize itself through the thickness of the layer; the more rapid it is, the more does the layer of sulphate formed at the contact with the lead, tend to separate from the remainder of the active layer. Also, if, after having established a rate of discharge determined, the circuit be interrupted, we see the balance trace, no longer a straight line parallel to the axis of the time, which indicates the absence of change in the weight of the plates, but an ascending curve, which tends only slowly to become parallel with the axis; we see that under these

1. *Revue Industrielle.*

2. This line has for its axis the abscissæ of the axis of the time, and for axis of the ordinates of the variations of weight of the accumulator.

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conditions, the accumulator continues to make sulphate for some time on open circuit, showing thus, reactions which are produced in the thickness of the active layer, without emission of current, between the lead, the sulphate formed, the remaining bi-oxyd and the free sulphuric acid.

3d. *Phenomena produced in open circuit.* This method allows of the prolonged study of accumulators even on open circuit. In the latter case the register traces a right line parallel to the axis of the time, indicating that the charge is preserved without loss.

Nevertheless, if, after having charged accumulators with a powerful current, with abundant and long continued liberation of gas, the circuit be left open, the balance shows a relatively feeble and very slow increase in weight (5 grammes), at the same time the voltmeter shows that the potential, starting at 1.92 volts, tends slowly to a constant value of 1.87 volts. This probably results from the influence of the gas retained in the active layer. At the end of a short time the accumulator finishes by acquiring a constant weight and potential, and this constancy is maintained during the whole time of registration (40 hours).

Conclusions. The potential corresponding to the rate of charge is constant, as long as the register traces a right line inclined; the liberation of gas is not an indication of saturation, it is a cause of loss of energy and of destruction of the layer, which appears as much earlier than the completion of the saturation in proportion as the charging current is more powerful.

Rapidity of delivery has for result the diminution of the capacity practically utilizable; the chemical work immediately following the interruption cannot produce any useful result subsequent to the uniform delivery; for the effect produced, energetic at the moment of closing the circuit, decreases rapidly and is exhausted almost immediately.

Thick layers of active matter are then useful only when the delivery in relation to the unit of surface is sufficiently feeble, about .1 ampères per square decimeter (3.9 inches) of active surface; it is therefore advantageous, in the case of a powerful delivery, to augment the surface of the plates and operate on layers relatively thin; the limits within which we can usefully increase the thickness, depending on the delivery per unit of surface of the plates, and probably also on the constitution of the active layer, varying with the mode of construction or of formation.

ABSTRACTS AND EXTRACTS.

STREET CAR MOTORS.

Every day the demand for an acceptable street car motor becomes more apparent. Against motors so far tried there have been more or less objections, but to the observer it hardly seems that any of them have been tried with very much persistency. Many objections to something so much of an innovation as the doing away with horses on street cars, are simply prejudices which a reasonable amount of persistence would overcome. If it were not for the fact that it is so easy to fall back upon the use of horses, no doubt a motor entirely acceptable would have been found before this, but it seems to be easier to go back to the old method than to persevere in overcoming the difficulties that may be expected in the way of the application of any motor. There is a place for a motor that is just right, but the owners or officers of street roads have so far shown but little patience in their trial; they expect impossibilities in the way of something that shall be just right at the first trial. An electric motor for street roads would seem to possess special advantages, but does not seem to receive much attention. The first successful motor for this purpose that is placed on the track will have an important start in the race. In the meantime, unless there is more activity in the matter, wire cable propulsion may be improved until the introduction of any motor will be more difficult than at present. Important improvements are believed to have been recently made in cable roads, and perhaps with others to be expected it may be found the most desirable means of operating surface roads. However this may be, it is reasonable to suppose that horses will not always be used for the purpose.—*American Machinist.*

A NEW INCANDESCENT LAMP.

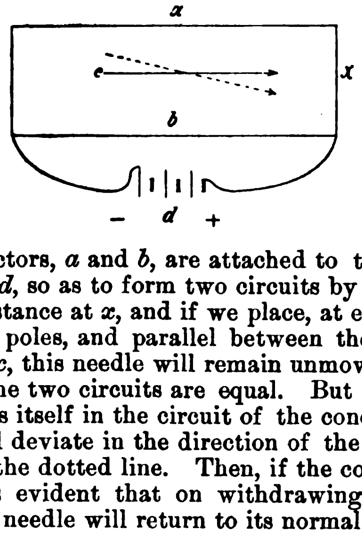
Mr. Max Muthel has patented in Germany an incandescent lamp which possesses the advantage of requiring no vacuum in the globe. He has very ingeniously overcome one danger that experiments of this kind have hitherto presented, and that is the fusion of the incandescent wire. The wire used by him consists of a mixture of bodies that are conductors and non-conductors of electricity.

He takes magnesia, silicate of magnesia, etc., and porcelain clay, and forms a fine thread of them which he heats to incandescence and saturates with a solution of platino-iridium salts, and afterward raises several times to incandescence in order to reduce the absorbed salts to a metallic state. Instead of the foregoing mixture, filaments of clay may be taken and saturated with a solution of a metallic salt, which is then reduced to a metallic state through incandescence and the use of oil of lavender or some other organic substance, or through an electric current. With wires thus prepared fusion is absolutely overcome, the presence of the non-conducting substances preventing the metallic parts from melting. Mr. Muthel supposes that the electric spark jumps, so to speak, from one particle to another, and in this way causes a heating of the other substances, which, brought to incandescence, emit a more intense light.

In order to make the filaments stronger they may be covered with chrome, the melting point of which is still higher than that of platinum. To effect this the filament is placed as an anode in a bath of chloride of chromium. —*La Lumiere Electrique.*

MICRO-OHM MEASURE.

In the various kinds of apparatus hitherto employed to measure electric resistances, irregularities in the indications frequently and almost inevitably occur. The chief causes of irregularity arise from the use of a plug commutator, which allows of sensible differences in the indications of resistance, because of the more or less perfect contact produced on inserting the plugs. M. Maiche has invented an apparatus whose performance cannot give rise to any error of indication. The principle can be thus explained:—



If two conductors, a and b, are attached to the two poles of a battery, d, so as to form two circuits by the interposition of a resistance at x, and if we place, at equal distance from the two poles, and parallel between them, a magnetized needle, c, this needle will remain unmoved if the resistances of the two circuits are equal. But if the resistance, x, exerts itself in the circuit of the conductor, a, the needle, c, will deviate in the direction of the conductor, b, as shown by the dotted line. Then, if the conductor, b, is movable, it is evident that on withdrawing it from the needle, c, the needle will return to its normal position, and the displacement of the movable conductor will correspond exactly to the resistance measured. In the apparatus the needle is placed between two movable bobbins.—*Illustrated Science Monthly.*

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EARLY HISTORY OF ZINC.

From the records of the Chinese we learn that they were acquainted with metallic zinc at a very early period. The metal was imported from India by the Portuguese in the seventeenth century, under the name of "spainter" or "spialter," before its nature was recognized in Europe. Whether the ancient civilized nations of the west were acquainted with metallic zinc cannot be ascertained; but there is a great probability that they were. The high degree of development of some of the ancient nations on the shores of the Mediterranean with regard to metallurgical operations, their very extensive manufacture and use of brass, make it most likely that they knew also metallic zinc and some way of extracting it from its ores. It is true that the writings of the old Greek and Roman authors do not refer to it; they regarded brass and yellow metal as only a colored copper, and the Greek word "chalkos," as well as the Latin word "aer," meant both copper and brass, though some authors, as Strabo and others, used sometimes the word "aurichalcum" for the latter. This, however, only related to the color, and meant nothing but a gold-like copper. If we consider the difficulty of communication and the continued and violent political revolutions in the ancient world, the absence of all the present facilities for spreading and preserving any knowledge, and, further, the fact that our historical sources consist chiefly of the fragmentary writings of a few philosophical scholars, we may easily conceive the possibility that some ancient knowledge may have been entirely lost to us. Our oldest historical documents—the writings of Aristotle and Dioskorides—refer to the manufacture of brass, by admixing an earthy substance, "kadmea," with the copper. The latter also mentions the application of zinciferous deposits from the brass kilns for the same purpose, and distinguishes from it the white oxide or flowers of zinc, under the special name of "pompholix." In his description of the latter substance he compared its appearance to that of wool, which gave rise to the new alchymical name of "lana Philosophica," much used by the authors of the middle ages.—*Industrial World.*

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed Editor of The Electrician and Electrical Engineer, 115 *Nassau Street, New York city.*

FACILITIES FOR INVENTORS.

[39.]—I observe that the London School of Electrical Engineering makes the following offer to inventors: "Inventors provided with every facility and the use of all necessary plant and machinery for testing or working out electrical inventions and improvements of every description. The utmost secrecy guaranteed, and advice given as to commercial value of new inventions. Private rooms and high professional assistance if required."

Is there any reputable school in this country which offers such facilities? I am aware that there are places where one can get work done at high prices, as in any shop, exposed to the gaze of crowds of students and visitors; but I do not know of any such facilities as those above offered. There certainly should be, however, in this home of inventors, with its boasted superiority to other lands. C. E. F.

New York, July 30, 1885.

LITERATURE.

RECENT PUBLICATIONS.

Association of County Surveyors and Civil Engineers of the State of Indiana. Proceedings of Fifth Annual Meeting. *Greenfield, Ind.* 1885. 8°. 81 p.

American Engineering Register. A classified list of professional engineers of all branches in the United States and Canada, embracing about 15,000 names. *Lewis M. Haupt*, A.M., C.E., editor. Engineer News Publishing Co., New York. 8°. 411 p., with appendix.

Gas Engines. William Macgregor. London: *Symons & Co.* 12mo. 231 p.

The Windmill as a Prime Mover, by Alfred R. Wolff, M.E., Consulting Engineer, Associate Editor American Engineer, Member American Society of Civil Engineers, etc. New York: *John Wiley & Sons.* 1885.

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Sale of the Bankers and Merchants' Property.—A Busy Day for Railroad and Telegraph.—The $5,000 Gift of the Western Union Telegraph Co.—Burglary Running to Seed.—Electric Time.—A New Telephone Proclamation.—Storage Batteries on the P. R. R. —The Commercial Telegram Co. Still Lively.—Ventilation of the W. U. Operating Room.—The Underground Commission.

The financial difficulties of the Bankers and Merchants' system appear to have been at least temporarily tided over, by the sale of the property to Edward S. Stokes, representing the newly organized United Lines Telegraph Co. The first steps to be taken are the liquidation of the claims against the property, which will require an expenditure of about a million and a half. Under the existing condition of telegraph affairs, it appears probable that considerable more money must be sunk before the system can be placed on a paying basis.

The Grant obsequies, Aug. 8, taxed the resources of the railway and telegraph companies in the city to an unusual extent. About 800 regular trains passed in and out of the Grand Central depot, many of them in two sections, in addition to which there were about 400 special trains. These trains were handled as rapidly as they arrived, and in perfect safety, as the interlocking switch and signal system worked admirably. About 93,000 messages were handled in the Western Union main office, and the telephone people were kept exceedingly busy. It is doubtful if any city in the country could have furnished equal facilities for moving and providing for such an immense gathering of visitors.

The appropriation of $5,000 by the Western Union Telegraph Co. for the Grant monument fund created considerable surprise among those who have been familiar with the latter-day policy of the great corporation. It certainly appears that a more liberal treatment of the living would be in better taste. It is to be hoped that this gift will not be followed by another "sliding scale" reduction, as was the case only a few years ago immediately after a large donation to the Vanderbilt university by one of the heaviest stockholders in the company. The following intimation that its officers and employés are expected to follow the example, should be especially relished by those who are called upon to perform extra service without compensation:

Western Union Telegraph Company,
Executive Offices, Aug. 12, 1885.

Resolved, That the general manager be requested to designate some officer of the company whose duty it shall be to receive from the officers and employés of the Western Union Telegraph Co. such contributions as they desire to make to aid in the erection of a national monument over the remains of General Grant, and that all sums so contributed shall be paid to the Grant Monument Association as the contributions of the officers and employés of the Western Union Telegraph Co. A. R. Brewer, Secretary.

Some time ago attention was called to the fact that burglary was waning as a profession, by reason of the protection afforded to property by the various electrical devices now so generally used. That the cracksmen are in a desperate condition is apparently confirmed by the fact that they broke open the cash drawer of the telegraph office at Castle Garden a few nights ago, and secured something over a dollar, mostly in pennies.

The local business of the Time Telegraph Co. has been transferred to the New York Electric Time Co., which has acquired the franchise and plant for the cities of New York and Brooklyn, also Long Island and Staten Island. This service has been very popular and satisfactory, and deserves to be still more extensively used. The office of the local company is at 15 Cortlandt street. The parent company will confine its business to the production of apparatus and the organization of sub companies.

An anonymous proclamation has recently appeared as an advertisement in one of our dailies, supposed to have been issued by the National Improved Telephone Co. It says that in addition to Philipp Reis; Holcomb, Gray, Edison, Van der Weyde, Pickering and Cross, all made speaking telephones long before Bell was known as an inventor, while the telephone made by Bell in 1876 was a failure. After devoting half a column of fine type to the misdeeds of the Bell company, it winds up with the following query: "How long will this patient people submit to these outrages?" We suggest that this terrible state of affairs is likely to continue at least eight long and weary years, but that meanwhile existence may be rendered comparatively happy by dispensing with the use of the telephone. It is different with a hand organ, to which one is often forced to listen, even when he does not subscribe for its support.

The Pennsylvania Railroad Co. is systematically continuing its experiments with storage batteries and incandescent lamps for the lighting of its parlor cars running between Jersey City, Philadelphia and Baltimore. The cells are charged at Jersey City, and supply the lamps for about seven hours. The arrangement appears to be superior to that of carrying gas in a reservoir, but no statement of the comparative expense has as yet appeared.

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The Commercial Telegram Co. continues to furnish quotations as of old, and is making an addition of two large dynamos to its already very complete plant. The same system is being started in Chicago and Boston, and will doubtless appear in other large cities very soon.

There is an immense field in New York for the introduction of small motors, driven by the agency of electricity. One of the favorite arguments in favor of the electric light as an investment was, that the power could be utilized during the day for such service. A Sprague motor is doing excellent service at the Western Union building, where it drives a ventilating fan on the south side of the operating room, which has been found to give great relief to the inmates, who have long suffered from the vitiated atmosphere prevailing there.

The commission on electrical sub-ways has held several meetings for the reception of plans for burying the wires. The following resolution was adopted August 18th :

Resolved, That every corporation, association or person using or desiring to use any electrical conductor in the city of New York, do forthwith file with this board such map or maps and other suitable descriptions as will fully inform this board concerning the location, courses, termini, space and all other details and requirements concerning the electrical conductors operated or desired to be operated by such corporation, association or person in the city of New York, to the end that this board may be enabled to make due provision for said conductors in the general plan and subway to be devised as aforesaid, and which it has full authority to require to be used for all the electrical conductors aforesaid.

The action contemplated by this resolution will necessitate intelligent study, to ascertain where the conduits should be provided and how many wires are to be accommodated. As the bereaved husband remarked to the sexton who was digging the grave, "let it be deep,"—when the wires are down, we want them to remain.

NEW YORK, August 24, 1885.

CHICAGO.

Frequent Storms, Cyclones, and Curious Freaks of Lightning—Rival Panoramas with Rival Arc Lamps.—Opening of the Grand Opera House.—Arc Lamps Ordered Off the Freeport Court House.—Return of the Western Union Pilgrims from California.—The City Hall Provided with Edison Lamps, Telephones and Lightning Rods.—The Field "Ticker" System Makes its Appearance.—Changes in the Board of the Western Edison Co.—An Arc Lamp Plant Raises an Alarm of Fire.

THE poet who sang:

"I would not live alway, I ask not to stay
Where storm after storm rises dark o'er the way,"

would hardly have selected Chicago, or for that matter, any part of the west this season. During some three or four weeks the elements have served us up a storm for breakfast nearly every day, and sometimes two or more at a meal. In nearly every instance these have been peculiar, and often quite novel in their manifestations. People have been struck without any more serious damage than having a boot sole torn off, an iron tool ruthlessly jerked away from them, or some other odd result, accompanied by a severe but not lasting shock. In one or two instances telegraph line repairers have been suddenly tumbled off the pole by surcharged wires. Cyclones have waltzed over the country from beyond western Minnesota to the Atlantic, doing damage to crops, buildings and fences, scattering household utensils and furniture, and in not a few cases killing animals and people in their race. Shade trees of many inches in diameter have been uprooted, carried away, and finally dropped when the grim destroyer considered them no longer a novelty as toys.

A third panorama has just been inaugurated here, and was thrown open to the public on the first of August. The three are illuminated by arc lamps, and each by a different system. The "Battle of Gettysburg" is shown by Van Depoele's, the "Siege of Paris" uses the Jenney," and at the last, the "Battle of Shiloh," the Excelsior people have placed their lights, so that comparative estimates of the efficiency of the three systems for similarly illuminated pictures may be made by any one who desires, and he may view three grand battles, at 50 cents each, any day.

The Chicago Opera House opens under the radiance of Edison lamps, on the 18th inst. It is a beautiful theatre, with a seating capacity of about 2,000. Being absolutely fire-proof, with a multitude of exits, there would seem to be no reason why the enterprise should be other than a successful one, if proper attractions are offered. The internal arrangements are everything that could be asked—unique, original and beautiful.

The electric light people and the county commissioners at Freeport, Ill., are at loggerheads about the lights on the court house dome. The company refused to remove them in accordance with an order from the board, and the board, at last accounts, were debating what action they should take to compel obedience to the order.

Col. Clowry, M. C. Bristol and C. H. Summers, of the Western Union company, have just returned from the Pacific coast, where they have been on a tour of inspection. The party were somewhat delayed, as they tell the story, one of the three having borrowed the entire funds of the other two, and expended the sum—15 cents—in investigating the mysteries and Joss houses of Chinatown, it is said with the intention of writing a book of experience and warning to the telegraph fraternity.

Our city hall has been "all broke up" by the Edison people, who have had a pretty tough time of it wiring the building for their system of lighting. Perseverance has secured success, however, and the result is remarkably satisfactory. Immediately after that work was commenced, the building was wired for telephone connections running to all the heads of departments, making a little telephone exchange system by which each may call up and talk with any other of the departments without the intervention of any one; and the lightning-rod man got in his work in the meantime, his line running from the top of a 75 foot flagstaff surmounting the building.

The county building, which adjoins the city hall on the east, is being wired by the United States people, who will have an equally if not more difficult piece of wiring to do there.

An opposition to or competitor of the Gold and Stock company, is about to make its appearance. The name of the new company is the "Chicago Commercial and Financial News Co." They purpose using a new form of ticker, which it is claimed is superior to the old, and requiring but a single wire. The company have one duplex wire to the New York exchange, and claim that their list of subscribers is rapidly filling up. They have the assurance from the market quotations committee of the Board of Trade that they shall have equal facilities with similar organizations here. The affairs of the company are in the hands of Mr. Bruce and county commissioner Van Pelt.

Several changes have recently taken place in the Western Edison Light Co. here. Gen. Stager's death left a vacancy in the presidency of the company, and another in the board of directors. The former is now filled by John M. Clark, Esq., late vice-president, and his place by A. F. Seeberger, Esq. The Hon. Robert Lincoln, late secretary of war, has been placed in the board, vice Gen. Stager, deceased. And again, Geo. H. Bliss, Esq., the general superintendent of the company, has resigned, to retire the first of September. Mr. Bliss has labored long and faithfully in his position, and though repeatedly importuned to accept tempting offers outside the company, has as persistently refused to abandon his chosen occupation, and he does so now with the kindliest feelings, which are fully reciprocated by his late associates. He accepts the position of secretary and general manager of the National Electric Service Co. of the United States, a general organization for the manufacture, sale and installation of Johnson's electro pneumatic apparatus for the controlling of temperature in steam and water-heated buildings. A large field is open to the new enterprise, and there is every prospect of success foreshadowed by the new management.

At the southern limit of the city, on Cottage Grove avenue, a new arc plant was recently installed, and the light suddenly flashed upon the vision of a fireman in the adjoining town of Lake. As the source of light was hidden from view, and as he was unaware of the existence of the plant, duty compelled him to turn in a fire alarm. This is about as near as Chicago has ever come to having a fire from electric lighting, and should be noticed by the gas people as "almost a dangerous fire from electricity."

CHICAGO, August 21, 1885.

PHILADELPHIA.

Another Electric Railway Project.—The Baltimore and Ohio Company Secures an Entrance to Harrisburg.—The Gas Interests at the Novelties Exhibition.—Serious Disturbances Caused by Atmospheric Electricity.—The Government Seeks to Economize in Electric Lighting.—Final Explosion of the American Sectional Underground Conduit.—Space Still to be Had at the Novelties Exhibition.

AUTHORITY has been extended by the Ridge Avenue Passenger Railway Co. to the American Electrical Railway Co. to lay a conduit and experimental line on Ridge avenue, from the Dauphin street depot to Laurel Hill cemetery. This section of the road has been chosen for the experiment because of the heavy grades, and in order to show how the new motor can surmount them in all weather. The work of building the plant will begin shortly. The conduit will be laid so as to avoid interference with the travel of horses, and the tracks will not be disturbed. The conduit will be of heavy timber below the surface. Running along just below the top will be the compound conductor, of copper and iron, half circular in shape, well insulated, and protected from damage from outside influences. On the top of the conduit forming each side of the slot, which will have a half inch opening, will be iron plates about five inches in breadth altogether. This slot opening will not be directly in the centre of

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the track, but to one side of the meridian line. The current will be transmitted by an ingenious contrivance from the conductor underground to the motor in the car, and will be under instant control of the driver or engineer. At intervals of 18 feet, plates will be arranged over the conduit which may be readily removed for repairs and other work, and without removing the body of the conductor. The bottom of the conduit will be cemented previous to filling in the ground about it. It is claimed that a speed of from 7 to 10 miles an hour can be attained for the experimental Ridge avenue line, with a saving of $2.50 to $3 per car over horse power.

At Harrisburg, on August 5th, the Baltimore and Ohio Telegraph Co. had the last barrier to its entering that city on the poles of the electric light companies removed by the court, which dissolved the injunction obtained against it last week by Charles H. Bergner. Argument was heard in the matter before Judge Sadler, who decided, in view of the fact that the defendant company did not now intend to string a cable near the premises of the complainant, that he had no standing. The new company will now commence business in that city. There was considerable interest in the matter, on account of the prevailing opinion that Mr. Bergner's action was in the interest of the Western Union Telegraph Co.

At the coming Novelties Exhibition the "gas men" are going to try very hard to oust the "electric light" people in public favor, as the managers of the Franklin Institute announce that it is gratifying to them to be able now to offer gas an opportunity of displaying its merits side by side with electricity. They assure the gas fraternity that the electricians will leave no stone unturned to demonstrate the cheapness and efficiency of their respective systems, and no half-hearted efforts of the gas men will offset the energy and alacrity of their rivals.

Electric storms have been quite frequent hereabouts of late. The nearness of the atmospheric disturbance to the earth was the marked feature of one of them. The thunder seemed to roll along the roofs of high buildings, and the lightning flashes to traverse the walls of top story rooms. The effect of the storm upon all electrical contrivances was apparent almost instantly. The lights at the ferries along the Delaware river were extinguished. There was trouble, also, in Washington, Franklin, and Rittenhouse squares. The work of transmitting and receiving the rush of telegraph matter was considerably impeded in the Western Union main office. Telephonic communication was for a long time suspended. At Lancaster, Pa., a telegraph pole was shattered and the lightning glanced off into the Pennsylvania railroad tower, igniting it; many wires were fused, and one of the operators was thrown to the floor and badly shocked.

Colonel Youmans, of the Treasury Department at Washington, was in the city a few days ago for the purpose of examining the system of lighting the post-office, with a view of reducing the expense thereof. He thinks that $500 a month can be saved in replacing 100 arc with large incandescent lamps. The cost of lighting the building at present is $2,000 per month.

The plant of the American Sectional Underground Conduit Co., which was laid along several blocks of Chestnut street, has come to grief at last. If you recollect, in a former number of the ELECTRICIAN AND ELECTRICAL ENGINEER I spoke of the explosion of foul air and gas in the man-holes of these conduits. They have become such a nuisance to people in general that workmen are now engaged in digging up the sections and carting them away. This is probably the best disposition to make of them.

The statement that has gained publicity, that no more requests for space will be granted at the Novelties Exhibition, is pronounced erroneous by the gentlemen in charge, as they have still considerable room left for desirable exhibits.

PHILADELPHIA, August 19, 1885.

BOSTON.

Electricity Given a Front Seat at the New Post-office.—Temporary Facilities of the Postal Telegraph Company.—The Judkins Electric Train Signals.—The Baltimore and Ohio reach Portland.—Present Officers of the New England Telephone and Telegraph Co.—Supposed Accidental Death of F. A. Gower.—A Jay Gould Story from "out west."

AFTER many years of toil and labor, the large and massive granite building used as the Post-office, Sub-treasury and United States Courts has been completed, and as a sign of its approach to completion the ugly fence which so long hid the front of the edifice has been removed, and the facade stands out in all the excellence (?) of government architecture. Its particular style one could hardly tell; the original designs were by the now celebrated Mullett, these were partly embodied in stone; then later genius took it in hand and completed it. For it has been one of the *glories* of this glorious country that no man, employed by the government ever lived, officially, to see the end of his labors from their beginning—"some other fellow" always comes in and makes "pi" of what has gone before, otherwise no one would know that he had ideas of his own. So the facade of the post-office, so called, fronting on Post-office square had to be re-arranged, and when all was supposed to be completed, two immense pieces of statuary were hoisted to the top of the walls. The building is of granite, and when these white marble pieces were in place they fairly stood out from their surroundings. They are, however, worthy of attention as being the work of one of our most talented young artists, M. D. C. French, of Concord, Mass. They are made of Vermont marble, and are 17 feet high. The group on the right, as it faces the square, represents Labor protecting the family and sustaining the Fine Arts; while the one on the left represents the purely modern idea of "Science controlling the forces of electricity and steam." This has three figures—Science in the form of a woman, seated in the middle, directing Electricity (a youth with winged feet) as she rests with her left hand upon the shoulder of Steam, who is chained to a wheel. The ideas sought to be conveyed by this statuary are: That Labor will protect the family and sustain the fine arts, and majestic Science will not be conquered, she will even direct the fiery element of electricity. The place given by the artist to electricity is significant. The strides that *that* child has made within a decade eclipse all other children of mother Science. Steam is great, even its capacities are not yet limited, but compared with electricity, the winged-footed child, it is indeed bound. Mr. French has been very successful in his art, and for one so young has achieved much.

The Postal Telegraph Co., which began business between Boston and New York a month ago, with an office at No. 4 Arch street, is still operating in an experimental way, transmitting its customers' despatches over the Commercial Cable Co.'s wires. It depends upon how the Bankers and Merchants' company's proceedings terminate to determine the future and permanent course the Postal company will take. At present its Boston office, quietly established, is but temporary, though the business is fair for the facilities in use.

The Judkins Electric Signal people are pushing their railroad train signal into use on the New England railroads. It gives satisfaction all around. One important feature of their devices, is the neat manner in which everything is worked out, all of their apparatus being effective and handsome in appearance.

The Baltimore and Ohio Telegraph Co. has extended its wires to Portland, Maine, and has reduced the 10 word rate to 10 cents. The Western Union company's charge has been 25 cents.

The Western Union Telegraph office in the Post-office building is one of the places in this city set apart by the national monument committee to receive subscriptions for the Grant monument.

The following is the roster of the New England Telephone and Telegraph Co. Theo. N. Vail, president; O. B. Parker, assistant to the president; Wm. R. Driver, treasurer; F. J. Boynton, secretary and acting auditor; J. N. Keller, general manager; W. J. Denver, assistant general manager (Mr. Denver has been recently appointed to this position, he has been manager of the Western Union Telegraph office in Springfield, Mass., for many years); John T. Wheeler, general superintendent; Chas. B. Wells, cashier; I. H. Farnham (formerly in charge of the telephone interests at Portland, Me.), electrician. David B. Parker is superintendent of the Boston division, having for his assistant in charge of the operating department, John J. Carty—who by the way is quite an inventor of telephone apparatus; the operating room contains many touches of his genius.

F. A. Gower who is supposed to have lost his life in balloon experiments, recently, in France, was connected with the early telephonic interests in this country and in this vicinity, several patents having been issued to him for telephone inventions. He with others inaugurated the telephone business in Paris, the Gower-Bell instruments being introduced there. He was said to have become quite wealthy.

An alarming letter appeared in the financial columns of the Boston *Herald* recently—purporting to come from the "rowdy west." The writer said it was rumored that the terrible Jay Gould, who appears to have nothing else to do, had secured a controlling interest in the American Bell Telephone Co., and had bloodthirsty designs upon all the local telephone companies; that as the inauguration of a gory and upheaving future, he had been the author of Mr. Vail's resignation from the general managership, and had speedily followed *that* up, by turning out Mr. Madden from *his* position. This financial-high-toppling letter writer says that western telephone stocks have been shaken by these reports, which would appear to have affected them something as a terrible cyclone would; and no doubt that when the western telephone stockholder hears the dreadful name of *Gould*, spoken in telephonic accents, he retreats hastily to his subterranean cyclonic chamber, and pulls the entrance hole in after himself. To one who knows that the Forbes, Hubbard-Bell and other connected and allied families hold the balance of the stock, and control the "monopoly," such hot weather yarns are extremely tiresome, and are in danger of giving one nervous prostration from their being so very wearisome.

BOSTON, August 19th, 1885.

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ELECTRICAL NEWS AND NOTES.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

SEMI-ANNUAL MEETING.

UNION SQUARE was enlivened on Monday evening, August 17th, with the presence of the advance guard of electric light representatives. The full attendance was in itself proof of the popularity of the Empire City for gatherings of this character. New York is perhaps less hospitable than some smaller towns, but visitors undoubtedly feel that they are at least granted the freedom of the city during their stay, and this in itself insures a pleasant trip.

The executive committee found ample business to engage their attention up to 3 P. M. on Tuesday, when the convention was called to order by President Morrison, who in his opening address remarked that among the subjects to be presented for discussion would be that of the proper insulation of lines; the feasibility and cost of underground wires for electric purposes; the comparative desirability of the tower system of lighting with that of lighting by poles; the comparative cost of producing electric lights by steam and water-power; electric motors and their relation to electric lighting in the production of power; the best form of dynamo; and the advantages of electricity over other illuminants for street lighting. An effort will be made during this convention to establish business relations between the different working companies; that is to say, to have such relations established as will lead to the establishment of a uniform price for electric lighting in the different parts of the country, and that without regard to the system by which the electric lights may have been produced. We propose to make an effort to bring about an equalization of the prices between the different manufacturers, so that, instead of destroying each other, this association may be the means of building up friendly relations between the different electric light companies of this country, and perhaps compel fairer play than you can coax out of what are known as the parent companies. That applies all the way down from the manufacturers of machinery to the manufacturers of carbon.

Mr. G. S. Bowen, chairman of the executive committee, reported that 62 names had been placed on the roll, and that $620 had been received by the treasurer, out of which expenses had been met to the amount of $415.67. The report was accepted.

An amendment to the constitution was also adopted providing for the admission to associate membership of "electricians, electrical engineers, and all those who are engaged in business collateral with electric lighting business," and to permit of the offices of secretary and treasurer being held by different persons.

The resignation of J. Summerfield Baldwin as secretary and treasurer was accepted, and the vacancy filled by the election of A. G. Rheinard, of Baltimore, secretary, and Charles Cooper, of Brooklyn, treasurer.

During the ballot for treasurer, which first resulted in a tie between Messrs. Linnell, of Hartford, and Cooper, Mr. Porter, representing the Pittsburg Carbon company, claimed the right to vote as an active member, on the ground that his principals operated an isolated plant, which at the first convention had been ruled as a sufficient qualification. Further inquiry developed the fact that the plant consisted of a one-light dynamo and a single Brush lamp. Notwithstanding the admission by the president that a Brush lamp was equal to 10 of any other pattern, he was constrained to decide in the interests of the association, and the Pittsburg gentleman was debarred from the right of franchise.

Quite a breeze was raised by the circumstance, however, which led to the presentation of an amendment to the constitution to the effect that the operating of electric light plants be construed as meaning only those who are carrying on a lighting business —not merely operating a plant for their own private purposes.

Mr. Wadsworth opposed the amendment, as follows:

"I hope this motion will not prevail, because, if it does, it will shut out from this convention the representatives of every mill in New England, and there are mills there operating plants of from 100 to 600 lights; and men operating a plant of that size certainly have a right to active membership here. It is desirable for the convention to get them here. It is desirable for this convention to hear from them the experience they have met with in operating those plants in cotton and woolen mills; and I know personally a good many of the representatives of those mills who are not only thoroughly posted in electrical matters, but who can give this convention, or any member of it, valuable information in regard to operating electric light plants. They operate all the various systems of the United States, both arc and incandescent, and at our meeting in Chicago we held out inducements to them to come here. We formulated this constitution with the understanding that they were to be represented, and I think at this late day it would be entirely wrong to say they cannot come into it."

Mr. Leggett—"I agree with Mr. Wadsworth's views with respect to the desirability of having such individuals or firms represented in this association, but it does not appear to me that they need to come here as regular members; but that the constitution, if it is not already by amendment made broad enough to permit these parties to come in as associate members, might be so changed as to permit them to come in as associate members without a vote. We can then have the advantage of their presence, and they can have the advantage of the association."

Mr. Duncan—"I think the amendment should prevail, for the very reason stated by Mr. Wadsworth in opposition to it. These mill men, when they see this association is run from a business standpoint, will then have some confidence in the association, and will be glad to become associate members and give us the experience of their training and their personal observation of their plant, but when they see that all outside interests, manufacturers of wire and everything else, may become full voting members in the association, they will lose confidence in it."

The chairman called Mr. Weeks to the chair, and said: "When the question of forming this association was first mooted at Chicago, this was one of the stumbling blocks in the way. It was discussed fully in all its bearings. The objection made there to the admission of such gentlemen as Mr. Wadsworth, such gentlemen as Mr. Porter, and other men who are virtually dealers in supplies, and not electric light men, was just such as Mr. Duncan has gone over now. On the other hand, the business in which they are engaged is so closely allied to that of electric lighting, being a part of the electric lighting business itself, you may say, it was very difficult to draw the line. The line was drawn, however, at this point—that a man who was a user of an electric light plant was entitled thereby to active membership in the association; but it was understood that the electric light plant so used was to be of sufficient size to entitle him to some consideration among electric lighting men. In other words, that the questions that would arise in this convention—that the result of questions, and the discussion upon them, would be for the benefit of the men who operate electric light plants. Now, I want to ask you, if a gentleman running a one-light Brush machine with one lamp in a carbon factory, representing the carbon interests absolutely and entirely, if he has sufficient interest in that one lamp burning out at Pittsburg to entitle him to be benefited in any way, so far as his electric light is concerned, by the discussions which take place in this convention? It was not the intention of the framers of this constitution; it was not the intention of the convention which adopted it; it was not the intention of the gentlemen who voted upon that constitution to make this association an association to advance the interests of men who dealt in electric light supplies. It was the intention of the framers of this constitution; it was the intention of the gentlemen who voted for the adoption of this constitution, that its beneficial results should accrue to those who were engaged in the business of electric lighting. But you will ask, 'Why do you take the money belonging to these gentlemen—Mr. Porter's company and others?' With a full knowledge on the part of Mr. Porter when he came into this room that he was only to be an associate member, he paid his $10 and received his ticket. In the hurry and bustle and crude form in which this association finds itself, starting on its first step before the public, Mr. Porter sits in the convention, and when his vote is required by some one else it is only then that he finds he is qualified to vote by reason of using a one-lamp Brush plant. Now, I assume that it is not the intention of this convention to depart from the principle it has adopted to make it an electric lighting association. The information which the members of the Electric Light Association receive from the dealers in electric supplies makes it very desirable that these gentlemen should be associate members of this association. The benefits which the dealers in supplies receive by being brought face to face and directly in contact with the men who consume their articles, make it desirable for them to be associate members, and thereby recoup themselves for whatever expense they may have incurred to attend this convention. I therefore assume that it is desirable on both sides to have the gentlemen in this business in this association. I feel it desirable, but it was believed proper and right to draw the line somewhere, and the line was drawn, as I have endeavored to explain to you. I have no objection to Mr. Porter; I have no objection to the representative of Benedict & Burnham, who operates a plant of 36 lights, and who asks me, 'Am I not eligible to active membership?' I said that question would be decided when the case of Mr. Porter was decided. Now, if this amendment to the constitution prevails, you will not only cut off Mr. Porter and those applying for the benefits of active membership, but you will deprive gentlemen already holding active membership in the association, of that membership. Now, I ask you, is it wise to press the amendment? Was it wise to press an application for active membership under this constitution? I claim that Mr. Porter's business is purely that of electrical supplies; that he has no interest in electric lighting other than his parallel interest in articles consumed in electric lighting. If Mr. Porter had a plant where he was employing an engineer to take care of his plant, it would be necessary to send that man here to give such information as might arise in the discussion. He runs one light. There is no information which Mr. Porter would carry home that he would apply to the light, but he would apply it to the carbon business.

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All these things make it unwise to force on this convention a questionable right to active membership."

Mr. Fishback—"I would like to know why Mr. Wadsworth is left on the other side of that line. Why is Mr. Wadsworth interested any differently from those other carbon factories that have as many lights?"

Mr. Morrison—"Mr. Wadsworth was operating a plant sufficiently large—this was the representation at the Chicago meeting—to make it desirable for him to seek information and to carry it home as regards the economical method of running electric lights; not to apply it in his business of carbon dealer, but to apply it in the electric light part of his business. Mr. Wadsworth was an active member of the association, elected as such at Chicago, and he brings his active membership here. If the amendment Mr. Leggett proposed prevails, Mr. Wadsworth ceases at once to be an active member."

Mr. Fishback—"At the convention at Chicago our claims were made and recognized. Yet to-day, in calling off the names, our company was omitted from the list. I intended to press the matter in a quiet way, but as long as it has been brought up, I would just like to know the reason, that is all. We are running a plant which is, I think, equally as large as the Boulton company's, and use it to light our factory at night."

Mr. Wadsworth—"When I became an active member of this association, I said I represented a plant. I do. I represent 35 lights, composed of about four different systems. Now, so far as myself being an active member of this convention is concerned, it is immaterial to me. It would make no difference to my business whether I was an active or associate member, but in the interest of other men, mill men and others, whom I know to be largely interested in this electric lighting business—men who have got two dollars for every one invested in this business by a great many members on this floor—I say that it is wrong that we make false promises in order to get what men in here we have got here representing certain private plants; and if we pass this resolution depriving them of active membership, they will not come here."

Mr. Morrison—"If I give the association the result of Mr. Wadsworth's special pleading, it will perhaps throw some little light on the subject. After he and the other gentlemen have been engaged in advancing the interests of the association throughout the United States, we have *one* mill represented in this national association—one mill—that is the Riverside Mill. I do not think, therefore, that that will affect the result."

Mr. Leggett—"I think the line should be drawn just where it was originally intended that it should be drawn, and to rule out companies, who are simply operating private plants, from active membership, and to include in the association just what was doubtless originally intended to be included—companies, firms or individuals who are operating plants for the purpose of furnishing light, renting lights, for private or public purposes. Now, there is a reason in this. Take the action of our executive committee as reported to-day upon the subjects for discussion before this convention—the feasibility and costs of underground wires, for instance. What has a private individual, operating an electric light for his own purposes, or a mill having a private plant—what interest have they in a subject of that character? Now, take another subject—the advisability of tower lighting in preference to pole lighting. You might take each subject right straight through that was named by our president to-day. Every one relates to that kind of matter which pertains to the public lighting plants. Now, it is a matter of very great concern to the lighting companies in this country to know about these things, and to organize themselves together into an association; and it seems to me that on matters which require a vote, on measures to be adopted, that those companies should not be trammeled in any way by the votes of parties, or individuals, or firms, or corporations, which are not interested in this matter of public lighting or renting electric lights. All these gentlemen are welcome here. They can get their $10 worth of information. This association invites them to speak on a certain subject. They are present to be heard, and they are present to hear. They can get all the information they seek, and we can get the advantage of their experience. But when it comes right down to a vote, upon matters which affect our interests as parties who are renting electric lights; as parties who are governed by municipal legislation, required to go underground, and required to go over ground; as parties interested in tower or pole lighting; when we are to have ourselves subjected to a vote by a party who has no interest in those things, no interest in common—that is, in those respects—it seems to me it is out of place."

Mr. Wadsworth—"I would like to ask why the manufacturers of electric lighting apparatus are not excluded. If you are going to exclude manufacturers of other supplies, why not exclude them? I would like to ask that as a matter of information."

Mr. Morrison—"Perhaps Mr. Leggett can answer that question. I know no reason why they should not be excluded."

Mr. Leggett—"I should say simply this, that we are dependent on that kind of thing. That comes right home to us. It is not so necessary with carbons. Carbon is in the nature of supplies, but when we come to purchase our supplies—when we want the thing made in this way or that way—those people are people who ought to be among us."

Mr. Bowen—"I agree most cordially with Mr. Wadsworth in the idea of putting a liberal construction on the membership of this association. We need the moral and pecuniary support of every man who operates an electric light, in my judgment. There are very few men operating electric light plants but can give us some information that would be valuable to us. With that thing in mind, I move that the whole subject be laid on the table, and that the constitution remain as it now is." The motion to lay on the table was lost.

Mr. King, of Baltimore—"I would propose that this matter be referred to a committee (of which I shall not be one) of three, to be presented to this association at some future time. It does appear to me, sir, that this is a very important matter. I look upon this as an association calculated to advance the interests of the electric lighting of the world. I believe, sir, that it can be such an association. If you admit all without any regard to their knowledge or attainments on the subject of electric lighting, you will have an unwieldy, large association. If you limit the active membership to those who are actively engaged in important matters of manufacturing plants, you will then be able to keep it in strict bounds; and, sir, is there any one here that would pretend to say that any gentleman who is interested in the electric lighting would not receive the value of $10 a year? I think not, sir. I think that the man who is engaged in running a very few lights will get a great deal more than his $10. For my part, sir, I do feel an interest in lighting, as you well know, and it was with a great deal of pleasure and anticipated information that I came here, and I yet expect to hear a great deal and to be amply repaid; and, therefore, I make the motion to refer this matter to a committee of three, in order that it may be presented at some future time." This motion prevailed, and the chair appointed as the committee Cooper, of Brooklyn; Leggett, of Detroit, and Weeks, of Kansas City.

Mr. Bowen—"There is at present in this city and Brooklyn an electrical commission. It seems to me it would be very proper to invite them to be present at the deliberations of this convention, and I therefore offer the following resolution:

Resolved, "That the Electrical Sub-ways Commission of the cities of New York and Brooklyn be invited to attend this convention, and be accorded all the privileges of the floor."

The motion was adopted, and the convention adjourned to 10 A. M., Wednesday.

WEDNESDAY—AUGUST 19.

The committee appointed to report on the amendment of Article 2 of the Constitution, submitted the following, which was adopted: "Members of this association shall be persons, firms or corporations engaged in the lighting business, to wit: that of supplying electric lights from a station to public or *private consumers*, as distinguished from such as are operating private plants, or engaged in the manufacture or sale of electric machinery, apparatus or supplies."

The last sentence in Article III. of the constitution was, on motion of Mr. Leggett, amended by substituting the word "consent" for "request" so as to read as follows: "Such associate members shall pay the same dues as members; shall be entitled to seats at all meetings, but have no vote; shall be ineligible to office, and shall be entitled to the floor only with the consent of the executive committee or presiding officer."

On motion of Mr. Weeks the following article was added to the constitution:

"Applications for membership shall be made to the president, and by him shall be referred to the executive committee, and they shall have power to act thereon."

A resolution was offered by Mr. Ridlon to the effect that a committee be appointed to consider the question of the necessity of the maintenance of uniform prices by the several manufacturing and lighting companies for all electric lighting apparatus and supplies.

Objection being made to the proposed legislation on the ground that it was impracticable, Mr. Weeks, of Kansas City, explained that it was intended more as a committee of conference than one of power. Competition in many cases had resulted in a general slaughter of prices, reaching in some cases but half the cost of production. He was of the opinion that the committee might in many cases exert a beneficial influence.

Mr. Cleveland, of Hartford, said that of course no committee could secure a combination. This question really illustrates the communion of interests between the manufacturing companies and the sub-companies. When a respectable company is running a service it is not fair for another company to come into competition with it with the result of making the stock worthless. This association should try to create a sentiment of fair play and a free field. Our company (the Schuyler) does not propose to engage in a cut-throat business. We have been invited to engage

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in competition, but have declined. We have a good system, and propose to cultivate virgin soil, believing there is room for all. In thus treating each other fairly we at the same time make our property a desirable investment.

The resolution was adopted, with the proviso that the committee be made up of one member from each system represented in the association.

Mr. Bowen then spoke in his most pleasant vein upon the superiority of the electric light over any other illuminant for public lighting. In the lighting of the public streets and large buildings there was no other light produced at so small an expense that produces such desirable results. For interior lighting where sub-division was required, of course the incandescent system was preferable. He looked forward to the day when its use would be general. Any innovation of this character will certainly meet with more or less opposition. In a western district with which he was familiar, five or six local gas companies had formed a syndicate, and every item which is considered discreditable to the electric light is, through its influence, spread broadcast through the daily press. He suggested that the electric light interests unite with a similar object in respect to the destructive nature of gas. He thought that every village of over 1,000 inhabitants would yet be supplied with the electric light. To-day, in the city of Chicago, several hundred men are employed to light and extinguish the gas lamps at a cost of $90,000 per annum, the whole expense being $320,000. The time occupied is forty-five minutes. Detroit, with its electric tower system, is lighted up by the simple turning of a switch. Mr. Bowen concluded as follows: "When Franklin succeeded in his efforts to control the lightning with his kite, the goodly people of Philadelphia thought him possessed of evil; now we cook our tea, run sewing machines, operate railway trains, light our Hell gates and our great light houses, send messages around the world, heal the sick, print our newspapers, make our homes and business places cheerful, and by its beautiful and brilliant effulgence illuminate our cities and villages, and yet we have only commenced the utilization of this subtle and wonderful force, that cannot be analyzed by the chemist, dissected by the surgeon, nor weighed by the grocer.........Again, give us the highest civilization we can enjoy; give us sound and healthy bodies; give us no more darkness, but give us light! More light! Give us the electric light. It is the poor, as well as the rich man's light. It will light the suburbs as well as the central portions of your cities. It is, in fact, the light for all."

Mr. A. F. Upton, of the Jarvis Engineering Co., followed with a paper upon the subject of power. This he considered the most important question connected with electric lighting. The cost of power was usually computed on a wrong basis. The point was to get the actual cost of running each lamp per hour. The first question was fuel. It had been decided that the most economical manner was to belt direct to the dynamo. The central station at Brockton, with the Edison system, was fitted up with a plain steel tubular boiler 6x16, having 140 three-inch tubes, 120 h. p. engine, 150 h. p. run at 80 lbs. pressure, cutting off at ¼. It supplied from 1500 to 1900 16 c. p. lamps. Their experience showed 22 per cent. in favor of bituminous coal, using waste material, wet or dry.

The lowest cost station within his knowledge was that of the Thomson-Houston system at Lewiston, Maine, which was run at a cost of $.002 per lamp, per hour for fuel only. The usual average was $.004 per hour, using screenings and soft coal. In fitting up stations it was well to remember that from 10 to 15 per cent. of the power was consumed in driving the shafting, and he had known it to run as high as 22 per cent. He knew of a station in New York city which was suspended two weeks on account of breaking a line of shafting. These were some of the objections to arranging stations in this manner. In the city of Lawrence, Mass., the Edison system was driven by two 12x12 70 h. p. engines. Four circuits with 10 miles of wire were operated, supplying 500 32 c. p. lamps at $650 per month. The letting of power was a subject worthy of consideration. Large numbers of motors could be let ranging from one-half to five h. p., paying a good profit. At the Thomson-Houston station in Brockton, Mass., a shoe factory was located on the upper floors to which power was supplied during the day, from which an additional revenue of $2,000 per annum was derived from a 35 h. p. engine. It was a curious fact that the starting of the Edison electric lighting system increased the sale of gas, and after the arc system was started the increase amounted to 10 or 15 per cent. Every gas company in Boston reports an enlarged consumption of gas since the advent of electric lighting. The Harrisburg, Pa., incandescent system with wires all overhead had paid a profit from the start. Contracts for lighting were made by the year, payable monthly. The cost of the fuel used was but 89c. per ton, being screenings from soft coal.

As a rule, Mr. Upton said, water power had been abandoned as being too unreliable. At Manchester the water had been very low at times, while at Lewiston and Holyoke the service had actually stopped at times on account of failure in water power.

Mr. Winchester, of Holyoke, said that his company was using a 30-inch turbine wheel with a capacity of 120 h. p. The price paid to the water company was $400 per year for day and $150 for night service per mill power, which was supposed to be equivalent to 80 h. p. It averaged perhaps about 70. The cost of water only, after the fitting up of the machinery, was about $1 per day. The plant consisted of 103 Schuyler lamps for which they received 50c. per night for single lamps, and 65c. for all night service.

Mr. Jepson, of Norwich, Conn., said that with a plant of 55 arc lamps, the cost of fuel per lamp per hour was $.004. Their monthly coal bill averaged $34, the lights running 7 nights per week, 6 hours. The company pays 2 per cent. quarterly dividend.

Mr. Ridlon, of Boston, stated that with 600 lamps in use, he used an average of three pounds of coal per lamp per hour, at an average cost of $3 per ton. His carbons consumed cost more than the coal. He wished to make it perfectly clear, especially to the representatives of the press, that the discussion had been confined simply to the one item of cost of fuel. There were numerous other items of cost which should be taken into consideration.

Mr. Sperry, of Chicago, said that there were large stables for car horses near their station, and that they had arranged to use refuse from this source. The horses being bedded down in shavings, the manure being used in the proportion of five parts to one of coal costing $1.60 per ton made satisfactory fuel. Special arrangements were required to burn it, a blast being necessary, also an additional fireman. A similar plan had been adopted at Minneapolis.

Mr. Weeks said that the cost of coal was of importance, and also the employment of competent engineers and firemen. Especially was it necessary that the fireman should understand the principles of making steam. Their boilers had been set about 28 to 30 inches above the grate. They had raised them to 36 inches and the result had justified the wisdom of the change. Their lamps were run from dusk to daylight at an average cost per hour per lamp of $.003 for the fuel used, which was bituminous slack, at a cost of five cents per bushel or $1.50 per ton.

Mr. Upton remarked that throughout New England the cost of coal used averaged from $2 to $2.50 per ton.

Mr. De Camp, of Philadelphia, referring to the question of direct *versus* indirect belting, said that their experience had led to the adoption of a 24x48 Corliss engine as a matter of economy. This engine drove 16 dynamos. They had one line of 66 feet of 6 inch shafting, with eight No. 8 dynamos, another line of 40 feet, part 4½ and part 3½ inch shafting, also eight dynamos, four of them, however, being number sevens. Objections had been made to the system adopted on account of the loss of power by friction. The actual loss, however, in excess of direct belting was less than seven per cent., while they felt that they could stand ten per cent. By this plant 800 lamps can be run, while it can be used economically for as small a number as 150.

The president, Mr. Morrison, said that the experience at the Philadelphia station had done more than anything else to settle the question of large *versus* small engines. His experience in Baltimore had also been in favor of large engines where there is the work to be done.

Mr. Officer, of Council Bluffs, Ia., sought information as to what was wrong about his plant. He was not sure whether it was the quality of the Iowa coal, or the fault of his engine, furnace or boiler. He was, however, consuming as high as fourteen pounds of slack coal per horse power, or nine pounds of pea coal. Its cost delivered at his boiler room was $1.57 for slack and $2.02 per ton for pea, the result being 34c. per ton in favor of the latter.

Upon resuming his seat, Mr. Officer was overwhelmed with suggestions as to changing his engine and raising his boiler.

His copious note book was well filled with valuable hints, and as Mr. Bowen subsequently remarked, the information which he would carry back with him would be worth ten times the cost of his trip.

Mr. Kerr, of Westinghouse, Church, Kerr & Co., stated that the quantity of coal consumed per square foot of grate surface was important to know as it was frequently the case that fuel instead of giving out the proper proportion of heat by thorough combustion, was simply distilled and its energy wasted.

The convention then took a recess until 2 P. M.

Upon reassembling, Mr. Leggett, of Detroit, read a very interesting paper upon the question of tower lighting *versus* pole lighting, based principally upon his experience with the former system at Detroit.

This, he said, was probably the best example in existence of tower lighting. The systems of street lighting had been based on the illuminants used. Gas was of moderate illuminating power, hence to have located such lamps at a height of 100 to 200 feet would have rendered them useless. There were in Detroit 2,600 street intersections. This would require as many lamps, which at 50 cents per night would cost $1,300. The tower lighting is more satisfactory than any other system. It produces an artificial moonlight effect, and walking or driving by night is possible without constant apprehension as to obstacles ahead. Teams coming from an opposite direction may be distinguished

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readily a block away. Not only the streets, but alleys and back yards are satisfactorily illuminated.

Union City, Indiana, in 1880, was the first place to introduce tower lighting, followed by Akron, O., and Cleveland, O.

John S. Adams, of Elgin, patented the skeleton tower which had now superseded the use of masts. Of these 200 had been sold and were now in use.

Detroit is a city of from 160,000 to 180,000 inhabitants. Its business section occupies about one square mile. Around this was a belt about one mile in width forming the residence portion of the city. Formerly 3,782 gas and naphtha lamps had been used, while large areas amounting to two square miles were not lighted at all. Not a single gas lamp was now in use. In 1884 the Brush company sought and secured the contract for lighting the city with the tower system at $95,000 per annum, for 66 towers of 100 feet, and six of 150 feet with 290 lamps. The company, however, erected 90 towers. In 60 days after the contract was executed, the towers had been built, the lines erected, and the city was lighted by the new system. The towers are located from 1,000 to 1,200 feet apart in the central portion of the city, and arranged triangularly; in the residence portion the distance is increased to from 1,500 to 2,000 feet; and in the suburbs from 2,500 to 3,000 feet. The total area lighted is about 10½ square miles. Detroit is now generally spoken of as the best lighted city in the world.

Evansville, Indiana, is lighted by 10 towers. During a recent cyclone, houses (both brick and frame) were destroyed, large trees torn up by the roots, and church steeples blown down, but the iron towers stood the test, not even a rod being bent. After this severe test, it is believed that nothing short of an earthquake can disturb them.

The gas companies made a bid to light Detroit at $40,000, but the Brush company secured the contract at $89,300. So bitter was the feeling against the possible return to the old system that in some sections the residents cut down the old naphtha lamp posts in order to prevent their use.

The most effective height at which to place the lamps was from 150 to 175 feet. After the latter elevation had been passed the lights gradually lose their power of illuminating the surface below. Five or six 2,000 c.p. lamps on the central towers and four on each of the others are used.

For a city of 12,000 inhabitants a central tower would be required with others placed at distances of 2,500 feet. A village of 5,000 inhabitants would require but a single tower. The total number of lamps used for lighting Detroit is 382, of which 24 are on poles; the latter, however, not being actually necessary.

In reply to a question by a member, Mr. Leggett said they had experimented with reflectors placed over the lamps, but could perceive no benefit from their use beyond protecting the lamps from the effects of the weather.

The breakage of globes was equal to the cost of fuel. A triangular frame had, however, been devised which could be fitted with ordinary flat glass, which, when broken, could be readily and cheaply replaced.

Mr. Bowen here read a despatch from Seneca Falls, N. Y., announcing that the tests of the 50,000 c.p. lamp recently erected there to light the town had not proved satisfactory, and that the use of kerosene would be resumed.

Dr. Otto A. Moses then addressed the convention upon the subject of "Incandescence." He was listened to with marked attention, and the gentlemen present who were principally interested in arc lighting apparently gathered from his words some ideas which were wholly new to them. Dr. Moses spoke substantially as follows:

"You have reached a point in arc lighting from which for some time to come we are not to expect very much improvement. You have been able to struggle against your common enemy, gas, and when you have eliminated it from the streets of the cities of the United States, you think the time has come for you to eliminate each other. Now, incandescent lighting has reached that point of development where in many places it has been able to compete with gas, and with arc lighting. If you examine the most remarkable installation of incandescent lighting in the world, the one bounded by Broadway, Wall street, etc., in the city of New York, you will not find one arc light running from the central station which supplies that incandescent light. And why? For the reason that it is a bagatelle. The amount of light that would be consumed in the streets in that incandescent district is so small as to be unnoticeable. You may say that it is a very large amount of money to expend in a small area, and for that reason they have taken a territory which in no way competes with the arc lighting company, and therefore their fields are distinct. The statement which I make is based on statistical observation. The street lighting of the city of New York is about five per cent. of the total lighting of the city, but in smaller towns the percentage is not more than three. The gas companies care very little about the street lighting, and oppose it principally to prevent the electric light from gaining a foothold. So you see that when you have conquered the whole field you cannot encroach on the field of the incandescent lamp. You will find that when you have the whole thing, it amounts to about five per cent. Who have the rest? Our common enemy, the gas companies.

"If electricity is to prevail as an illuminant, it can only be by means of the incandescent light. Now, then, since the arc lights have reached a point of perfection, we will consider why they cannot extend their domain. In the first place, arc lights have reached a certain point of the development where the elements of light giving are fixed; a certain amount of electromotive force, almost a standard, an arc varying from an eighth of an inch to half an inch; a standard of carbon—perhaps of seven-sixteenths of an inch average—all these things are fixed. The length of line, attendance, cost of carbon, breakage of lamps, all these things are fixed. You cannot get any more light out of an arc lamp than you are getting to-day. You will get, as Mr. Bowen remarks, 50,000 candles; you may get a quasi 2,000. Now, in comparing an arc light and an incandescent light, you will find that an arc will give a great deal more light for the fuel consumed, I think you may say five times as much light as an incandescent light, for the fuel. But every one will admit that through the consequent sub-division of light in the incandescent light you get what is more than commensurate. As to the cost of supplying carbons, that is more than the cost of supplying the filament for the incandescent light, so that we can eliminate that. We come, laying aside the first investment, to this fact, that you can get five times as much light per pound of coal consumed, in the arc light than you can in the incandescent light. But I think you will all admit that you are not going to get any more out of your arc lights. That has reached its limit. The problem is simple and has been solved. Now, where is the limit of this fledgeling incandescent lamp? The incandescent lamp that was used in the beginning of 1879, the experimental lamps of Sawyer and others, were not economical at all; they used large conductors in vacuo, but the vacuo was imperfect. Finally, in one great step, the world saw in 1879 and 1880 a sudden departure in the mechanism of incandescent lamps. The principles all existed. They were known since 1846, from the time of Starr, who took out a patent on the incandescence of carbon in vacuo. His vacuum was very poor, and his carbon was a thick rod. In 1879 incandescent lighting, after a very long gestation, was born. We have to-day an infant seven years old that I think is going to strangle gas with one hand and petroleum with the other. That infant is a very robust one. He is to-day competing with a very well-developed man. He is competing with arc lighting. He is also competing with gas lighting. And is he to stop his growth in his seventh year? I think that is asking too much of him, particularly when he has in New York and elsewhere, some very good foster-mothers, who are supplying him with all the experimental food that he may need, and he is gradually developing and will continue to develop. But as he is he can hold his own in competition with gas and arc lighting to a certain extent, an extent that implies his great development. Now, what is he going to be in the next seven years? Let us see where his elements of progress lie. Let us consider the limit to begin with. We find that the incandescent lamp, as it exists, is a very small filament of some hydro-carbon substances. You find Cruto, in Italy, making a carbon much smaller than is now used, piled up by deposition from gases. He takes a material that is already an excellent conductor of electricity, and deposits his carbon on it, and then he builds up a perfectly solid and homogeneous material that produces a wonderful economy. It costs a good deal, but that is nothing. The first lamps cost $150 each. The day will come, gentlemen, when you will see carbons made just as easily as thread is made by the Willimantic company. It is simply necessary to time your deposits. Now, when that can be done, and that is simply a matter of mechanical ingenuity, you will get, instead of the present economy of nine 16-candle lamps or ten 16-candle lamps, 30, 40 or 50. I will take a carbon to-day, and bring it to a point of incandescence where it will represent one hundred. That is a question of fineness of carbon. I have succeeded in making filaments as fine as the web of a spider. The life of the lamp has to come from other matter. That is the result of experience and the integral character of the material employed. When that day comes, the death-sentence of gas has been passed. It is simply a question of burning coal under boilers. To-day the cost of the incandescent lamp is less than one mill per hour. You, gentlemen, spoke of exceptional cases of arc lights being run at a cost of two mills. Give me the coal to burn under the boiler, and one mill will be the only cost of the incandescent lamp. Give me plant and coal and fixed capital, and the other is simply a matter of the cost of the lamp, which is at the present prices simply one mill per hour. This is based on the life of one lamp at one dollar for one thousand hours. The subject is an endless one, and you will excuse me if I retire and allow others to speak." [Applause.]

The president complimented the speaker upon the extremely instructive and interesting character of his address, and admitted that the arc light must stop at the door of the dwelling, or of the hotel, excepting the lobby, but thought that it was entitled to a little more than 5 per cent. of the lighting business. No one would permit such a lamp in his bed-room, for instance; it

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would be worse than a first-class case of the "jim-jams." He thought that the arc light had reached a point at which it became a business success. "I take it," said he, "that every man in this room, because you are all thinking and intelligent men, will have carried away a 'bee in his bonnet' that will keep him thinking for some time to come. When I say 'we' I mean the men who have their brains and their money both in electric lighting, and are eternally searching for something that will be of a greater commercial value than what we now possess. We are looking forward to the time when we will have these promises redeemed in the incandescent field. I believe the near future is pregnant with great results in the field of electric lighting. We will wait for that. We will let the gentlemen who have started experiments keep them up until we get along to a point where we can make money."

Mr. Holt of the Brush company, Cleveland, addressed the convention on the subject of arc and incandescent lamps on the same circuit. He said: "In Grand Rapids, Mich., the Thomas cut-out is used, and reported highly successful. The system is one to which any kind of incandescent lamp may be adapted. The lamps are arranged in groups. The system run by the Brush company embraces seven groups, connected to their 2,000 candle power circuit. In connection with each group, is put in what is called a multiple series cut-out, and so arranged that if one or more of the lights should go out, this cut-out operates either to short-circuit the group and extinguish the rest of the lamps, or in some cases to throw in a resistance equal to the number of lamps cut out. Or in other cases to throw in a resistance which is somewhat less than the working resistance of any of the lamps, consequently, the remaining lamps are dimmed only. Of course the cut-out is better for the general circuit, but with the other, the lights being simply dimmed, the consumer is not deprived of all light. He can immediately tell which lamp has failed. You can readily see that this system can be adapted to almost any circumstances, except those of house lighting. We do not recommend it for house lighting, because there is a well-founded prejudice against introducing high tension currents into houses. But for stores, offices, hotels, and all places where people prefer the incandescent light to the arc light, it is a system that is beautifully adapted."

A brief general discussion ensued, which tended to confirm the wisdom of the Brush company in not recommending the general adoption of a mixed system, as it was evident that the fundamental principles of electrical distribution were not sufficiently understood to warrant the promiscuous introduction of incandescent lamps upon arc circuits.

At 5 P. M. the convention adjourned until the following day.

THURSDAY—AUGUST 20.

The location of the next meeting of the Association was the first work of the day. The city of Baltimore had been selected by the executive committee, and the time fixed for February, 1886.

Mr. Wadsworth, of Cleveland, with an eye to the geographical fitness of things, ever mindful of the fact that Ohio is the heart of the country, suggested that as the first convention was held at Chicago, and the present one as far east as New York, it would be wise to select a more central point. Modesty appeared to stifle the suggestion that Cleveland was the spot—he hesitated and was lost, for the ever ready president reminded the members that we were yet in the early stages of the new Democratic administration; that Congress would then be in session, and he believed that a majority of our citizens would have business in Washington at about that time, and it would be necessary for them to pass through Baltimore. In fact, it was hardly possible to get anywhere without going through Baltimore.

Sundry remarks as to the well-known hospitality of the genial president, the superiority of the oysters and terrapin, neutralized all further objection, and the action of the executive committee was confirmed. A committee on transportation was then appointed, consisting of Messrs. Wadsworth, Weeks, Bowen, Ridlon and Cleveland.

A resolution was adopted officially locating the headquarters of the Association at Baltimore, Md., to be a repository of all information pertaining to electric lighting and kindred topics, and also that correspondence be solicited with all home and foreign associations.

A committee was appointed consisting of R. W. Pope, of the ELECTRICIAN AND ELECTRICAL ENGINEER, W. J. Johnston, of the *Electrical World*, and George Worthington, of the *Electrical Review*, to select the names of prominent electricians in foreign countries, whom they might consider as worthy candidates for honorary membership.

E. A. Sperry then presented a valuable paper upon "The Best Form of Dynamo," illustrated by blackboard diagrams. (See page 324.)

Mr. Spang, of Reading, who had been listening attentively to the points brought out by Mr. Sperry, arose to demonstrate that the Ball dynamo was the proper form, but he was reminded by the president that the respective merits of different varieties of dynamos were not proper subjects to be brought before the convention. Debate must be confined to the general principles which were common to all.

Mr. Spang, resuming the floor, continued his remarks, guided by the cautionary advice of the president, and after mentioning the severe tests which the unipolar dynamo had undergone in the new Croton aqueduct work, he introduced the following resolution, which was adopted:

Resolved, "That a committee of three be appointed, who shall send a communication to each company manufacturing dynamos, requesting them to submit a 5–10–15 ampère machine, capable of producing not less than 30 arc lights, and an incandescent machine capable of producing not less than 200 incandescent lights, within one year's time, to the association, to be tested by them."

Mr. F. J. Sprague, of New York, followed, and demonstrated by diagram and formula the correctness of Mr. Sperry's theories.

Ralph W. Pope, of New York, followed with a paper upon the subject of "Placing Wires Underground." (See page 334).

George H. Benjamin, of New York, stated that he had made the subject a study, and had made many experiments in connection with Dr. Siemens. He was fully convinced that the most satisfactory system must be an underground conduit in which the wires were to be placed bare, and from which they could be removed if necessary. He believed that no difficulty would be experienced in burying the wires, and that we were being frightened by a bugaboo. The cost of placing the wires underground was about 30 per cent. more, but the subsequent repairs would cost 150 *per cent.* less.

Mr. Sperry said his company was operating about two miles of wire underground, and that his experience was that it was expensive principally on account of the troubles which occurred where the wires passed through the area ways. It was his company which operated a 42-light plant the wires for which were naked, and ran through the tubes in the manner described by Mr. Pope. This was merely an experiment to test the insulating quality of the conduit, which thus far had proved satisfactory. The wires were not introduced as conductors, but were intended for eventual use as draw wires.

Mr. De Camp was of the opinion that the expense of maintaining overhead wires had been very much exaggerated. He happened to have with him a memorandum of the cost of maintenance for seven months of 67 miles of overhead wire. The average is $\frac{17}{100}$ of a cent per day per lamp.

The president (after sundry questions and a little figuring) said: "It appears Mr. De Camp takes care of his wires for about $1.36 per day, He must have one lineman, at about $10 per week. Now this is a pretty important matter for some of us. If my directors find out what it costs Mr. De Camp to maintain his wires, I shall find a great big club in soak for me when I get home. I want this explained. Does not the city furnish the poles?"

Mr. De Camp—"Yes; they keep up the poles, and their renewal is not included in these expenses; but we paint the poles, and would be glad to have our own."

Mr. Curtiss, of Cleveland—"I would like to ask Mr. Benjamin that if he had his money invested in electric lighting, he knew of any underground system which he would recommend to place his wires in."

Mr. Benjamin—"I would answer that by saying that I do not think I would put my money in the electric lighting business. However, if I was in a position where I could supply 600 subscribers, I would put down a lead-covered cable."

Mr. Holt—"It appears to me that if the electric light companies were required to erect a straight line of poles, having say electric light wires on the lower arms, telephone wires above, and telegraph wires still higher up, occupying both sides of the street, that most of the objections to overhead wires would be overcome."

W. O. Callender, London, England, followed with a few remarks regarding insulation underground. He said that during the past year the increase of incandescent lighting in England had been extensive, while the arc system is gradually disappearing. With the exception of those used at the railway stations he did not believe there were more than 500 arc lamps in use. An insulation for underground use must be a material which is unaffected by drouth, dampness, the earth, sewer gases, or escaping illuminating gas, with which the ground in large cities is thoroughly impregnated. "After many years' experience with bitumen in making asphalt for paving purposes, I found that it was practically indestructible. In 1869 I laid down a very large work in London and recently took up some samples, which upon comparison could not be distinguished from pieces directly from the factory. After experimenting considerably with a view to making it plastic, I succeeded in producing a substance which I call bitite." (Mr. Callender here exhibited a series of plans for placing wires underground.) In reply to a question how he would lead a loop from the interior of a mass in which the wires were solidly imbedded, he said that the plan shown was prepared at the request of the United States and Brush companies,

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to show how trunk wires would be carried from one point to another where they would not need to tap them.

After a brief discussion, during which Mr. Callender made further explanations of his plans, the president announced that the hour of adjournment having arrived, he would briefly thank them for their courteous treatment of him, more especially as their only rule of government was the gavel. Having then announced the appointment of the following committees, to which additions would be made from time to time, he declared the convention adjourned.

COMMITTEES.

Conference Committee on Uniformity of Prices for Apparatus and Service, Frank Ridlon, Brush-Swan, Boston; Charles Cooper, Thomson-Houston, Brooklyn; George S. Bowen, Van Depoele, Elgin; W. A. Chase, Schuyler, Holyoke; C. B. Ver Nooy, Sperry, Chicago; Mr. Lyne, Ball, Jersey City; A. L. Ide, Fuller, Springfield, Ill.; A. J. DeCamp, Brush Electric company, Philadelphia; Thomas Smith, Ft. Wayne, Jenney, Peoria; George D. Guernsey, Excelsior, St. Louis.

Electricity as an Illuminant, Messrs. Bowen, Chicago; Moses, New York; Sperry, Chicago; Cleveland, Hartford; and Holt, Cleveland.

Proper Construction and Maintenance of Wires, Messrs. A. J. Holt, Cleveland; A. J. Dalzell, Hartford; P. Fahay, Boston; S. A. Duncan, Pittsburg; E. R. Weeks, Kansas City.

Steam Power, Messrs. Ide, Springfield; D. E. Evans, Baltimore; De Camp, Philadelphia.

Underground Lines, Messrs. Ralph W. Pope, New York; E. A. Sperry, Chicago; W. R. Patterson, Chicago.

Incandescent Lighting, Dr. Otto A. Moses, and others.

History aud Progress of Electric Lighting, George Worthington, *Electrical Review*.

History and Progress of Electricity as Applied to Motors, W. J. Johnston.

Electric Lighting in Canada, C. A. Ross, Montreal, Canada.

Measurement of High-Tension Currents, Best Instruments for, C. J. Van Depoele, Chicago; Prof. Thomson and E. J. Houston, of Philadelphia.

Best Equipment for Arc Lighting Stations, D. E. Evans, of Baltimore, and N. S. Possens, Cleveland.

Operating Expenses, E. R. Weeks, Kansas City; A. J. De Camp, Philadelphia; D. W. Guernsey, St. Louis; George O'Connor, New Orleans; E. H. Goff, New York; H. C. Tudor, Baltimore, Md.

Line Wire, Best for Overhead Lines, Size, Insulation, etc., H. M. Cleveland, Hartford.

Carbons and Globes, Frank Ridlon, Boston, and others.

Storage Batteries, A. J. Holt and George H. Benjamin.

Motors, Charles J. Van Depoele and Wm. Hochhausen.

Arc Lighting, Wm. Hochhausen.

The following named gentlemen were in attendance during the convention :

Angell, Fred.—American Electrical Works, Providence.
Adams, H. C.—Holmes, Booth & Haydens, N. Y.
Allen, George D.—Excelsior Co., Brooklyn.
Buckley, W. J.—Chicago
Baxter, Wm. Jr.—Baxter E. L. Co., N. Y.
Benjamin, Geo. H.—Constant Current Electric Storage Co., N. Y.
Baker, W. H.—American Electric Manufacturing Co., N. Y.
Baird, M. E.—Holmes, Booth & Haydens, N. Y.
Bowen, George S.—Elgin Electric Light Co., Elgin, Ill.
Beetle, George L.—Lytle & Co., N. Y.
Brintnall, H. L.—East Saginaw, Mich.
Blakeslee, G. G.—Benedict & Burnham Manufacturing Co., Waterbury, Ct.
Cleveland, W. B.—Forest City Electrical Works, Cleveland, O.
Candee, J. N.—Brooklyn, N. Y.
Callender, W. O.—Callender Insulating Co., Newark, N. J.
Callender, C. M.—Callender Insulating Co., Newark. N. J.
Carmen, Henry C.—Tesla Electric Light Co., Rahway, N. J.
Cleveland, H. M.—Schuyler Co., Hartford.
Cooper, Charles—Municipal Co., Brooklyn.
Curtiss, C. C.—Brush (parent) Co., Cleveland.
Coggeshall, Mr.—Mitchell, Vance & Co., N. Y.
Coughlin, W. H.—Worcester, Mass.
Condict, J. E. & H.—San Francisco.
Dam, A. J.—Hotel Dam, N. Y.
Donaldson, G.—St. Paul, Minn.
Dustin, Charles—Schuyler Co., Hartford.
Duncan, S. A.—Brush Co., Pittsburg.
De Camp, A. J.—Brush Co., Philadelphia.
Elder, J. S.—American Electric Manufacturing Co., N. Y.
English, James—Electric Light Co., New Haven.
Fayhay, P.—Brush-Swan Co., Boston.
Fishback, L. M.—Parker-Russell Carbon Co., St. Louis.
Guernsey, D. W.—Guernsey & Scudder, St. Louis.
Goff, E. A.—American Electric Manufacturing Co., N. Y.
Gilbert, F. H.—Electric Light Co., New Haven.
Garrett, R. S.—Southern Electric Co., Baltimore, Md.
Hill, J. M.—Chicago, Ill.
Hunt, W. T.—*Electrical World*, N. Y.
Harrington, F.—Western Electric Co., N. Y.
Hochhausen. Wm.—Excelsior Co., Brooklyn.
Holt, A. J.—Brush (parent) Co., Cleveland.
Hotchkiss, Clark B.—Day's Kerite Cable, New York.
Heap, Maj. D. P.—Secretary U. S. Lighthouse Board, Washington.
Ide, A. L.—Ide Engine Co., Springfield, Ill.
Jepson, Joseph.—Thomson-Houston Co., Norwich, Conn.
Jenks, W. J.—American Electric Manufacturing Co., N. Y.
Johnston, W. J.—*Electrical World*, N. Y.
Jones, O. L.—Domestic E. L. H. & P. Co., Boston.
Key, J. B.—Okonite Co., N. Y.
Kelly, J. F.—Electrical Supply Co., N. Y.
Kerr, Walter C.—Westinghouse, Church, Kerr & Co., N. Y.
King, F. W.—Brush Co., Baltimore.
Linnell, H. M.—Schuyler E. L. Co., Ill.
Leggett, W. W.—Brush E. L. Co., Detroit.
Lytle, H. B.—Lytle & Co., N. Y.
Libbey, A. L.—Globes, Boston.
Morss, Everett—Morss and White, Boston.
Moses, Otto A.—New York.
Mayo, George A.—Mayo Electric Co., Boston.
Morrison, J. F.—Brush Co., Baltimore.
Moore, John J.—Springfield (Mass.) Electric Light Co.
Millis, Lieut. J.—In charge of lighthouse experiments at Hell Gate and S. I.
Moore, Alfred—Wire, Philadelphia.
Martin, T. C.—*Electrical World*, N. Y.
Noonan, J. F.—Paterson Electric Light Co., Paterson, N. J.
Nicholson, Mr.—President Ball Engine Co., Reading.
O'Beirne, E. J.—Star Iron Tower Co., Fort Wayne, Ind.
Officer, Thomas.—Council Bluffs Electric Light Co.
Parker, George W.—Parker-Russell Carbon Co., St. Louis.
Porter, George F.—Pittsburg Carbon Co., Pittsburg.
Pope, Ralph W.—ELECTRICIAN AND ELECTRICAL ENGINEER, N. Y.
Price, Charles W.—*Electrical Review*, N. Y.
Ridlon, Frank—Brush-Swan Co., Boston.
Rolfe, Charles—Western Electric Co., New York.
Shippey, H. L.—J. A. Roebling's Sons Co., N. Y.
Stiles, A. K.—Van Depoele Mfg. Co., Chicago.
Sperry, E. A.—Sperry Co., Chicago.
Spang, H. W.—Ball Co., Reading.
Stanley, H. D.—Bridgeport Brass Works, Bridgeport, Conn.
Smith, Gilbert M.—Ansonia Brass and Copper Co., N. Y.
Sheriff, J. B.—Sheriff, Son & Co., Pittsburg, builders of high-speed engines.
Stump, C. E.—*Electrical World*, N. Y.
Sprague, F. J.—Sprague Electric Railway Co., N. Y.
Thayer, H.—Western Electric Co., N. Y.
Tuxworth, D. H.—Southern Electric Co., Baltimore, Md.
Upton, A. F.—President Jarvis Furnace Co., Boston.
Waring, R. S.—Standard Und. Cable Co., Pittsburg.
Weeks, E. R.—Thomson-Houston Co., Kansas City, Mo.
Winchester, R. C.—Holyoke (Mass.) Electric Light and Power Co.
Wadsworth, George—Boulton Carbon Co., Cleveland.
Wiley, George L.—Waring Cable, N. Y.
Worthington, George—*Electrical Review*, N. Y.
Wetzler, Joseph, *Electrical World*, N. Y.

AFTER THE ADJOURNMENT.

During the last day's session of the electric light convention a cordial invitation was extended by the Messrs. Callender to all the gentlemen present to visit their insulated wire establishment at East Newark, N. J., for which purpose a special train would be provided, leaving Jersey City Friday evening. There, might be seen a plant of about 50 arc lamps supplied through wires running over head, under ground, and under water.

As over 24 hours had intervened since the adjournment of the convention, the representatives from out of the city were not plenty. Mr. Thos. Officer, of Council Bluffs, Ia., was present, with a look of determination on his countenance, as if he was bound to gather a winter's supply of information before he left this city. New York and vicinity contributed a goodly number of visitors, however, and the waiting car on the Jersey side was quickly filled with about 50 people electrically inclined. The visitors were cordially welcomed at the factory, a brilliant spot in the surrounding gloom of a cloudy evening. Messrs. W. O. and W. M. Callender, manager Thompson and superintendent Henderson, each took charge of their respective quotas of "visiting statesmen," and pointed out the various stages of the manufacture of insulated wires and cables. The material is mixed in the basement below, and subsequently vulcanized in large ovens, the latter process requiring five or six hours. This part of the manufacture was temporarily suspended, it being kept secluded from the public gaze. The "bitite," as the compound is named by Mr. Callender, is next thoroughly masticated by running through a pair of heavy cutting rollers, after which it is passed repeatedly between two smooth rollers, by which it is rolled into thick sheets. These sheets being cut into strips, are fed into a die through the centre of which passes the wire, the bitite being closed in upon it, making a perfect covering. As this process heats the insulation, the wire as it leaves the die is led through a trough of running water about 75 feet in length, and it is thoroughly cooled. After this process the wire may be spirally wound with tape, covered with braid, or specially treated according to the requirements of the customer. All of the wire manufactured is thoroughly tested by being immersed in large tanks of water provided for the purpose, where the electrical measurements are conducted with the same care, and by the same methods as are used in connection with ocean cables. The testing room is very neatly and thoroughly fitted up with a reflecting galvanometer and accompaniments. The instrument table is formed of a slate slab supported upon an independent timber framework, passing through the floor and imbedded in masonry in the earth. Immediately adjoining, in a convenient corner, a well-filled table, ornamented with bouquets, riveted the attention of the guests, as they gradually assembled after their tour through the works. Sundry flowing bowls were observed, containing various liquids, nicely graduated to suit the tastes of a promiscuous assemblage. A pleasant hour was passed in this spot, when the announcement

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of "all aboard" reminded the revelers that time was up, and the waiting train soon carried away a well satisfied company, comprising, among others, M. W. Goodyear, T. C. Martin, Clarence E. Stump, Joseph Wetzler, R. W. Pope, Wm. Hochhausen, Otto A. Moses, Thos. Officer, W. J. Jenks, E. M. Bentley, L. Stieringer, John Stanton, Dr. O. Lugo and E. T. Barbarie.

REUNION OF MILITARY TELEGRAPHERS AND OLD TIMERS.

WHILE resenting the intimation that he is growing old, the true "old timer" is proud of his bald head or gray hairs, knowing that they represent a record. It is eminently fitting that these organizations should blend harmoniously, for the telegraphers at home were scarcely less important in the service of the country, in those stirring days, than were those who bivouacked at the front—the clicking of whose sounders mingled with the din and tumult of battle, siege and skirmish.

When the meeting of the military telegraphers was called to order in this city at 11 A. M., August 19th, a beautiful steel engraving of General Grant, under which resolutions of sympathy and condolence were handsomely engrossed, was exposed to the view of the members. The work, although large, was finished according to the utmost good taste, and brought forth unanimous approval. The picture will be exhibited at future meetings of the society. President Plum's report was quite lengthy. He dwelt largely on the necessity of pressing for recognition from Congress in the shape of pensions, especially for those who are now suffering from diseases contracted by service in the war. Several urgent cases of destitution that had been brought prominently to his notice were cited. Twenty odd new members were then admitted to the association, and fitting resolutions on the death of General Stager were adopted. The treasurer's report showed a balance of $151.85 on hand. A message of sympathy was despatched to L. J. Kelley, of Painesville, Ohio, stating that it was with regret that the members of the association learned of his total blindness, which was caused by exposure during the war. An assessment of $3 was levied to meet any cases of want and destitution that may arise. By vote $500 was appropriated for congressional purposes. The old office-bearers were then unanimously re-elected. They are as follows: W. R. Plum, of Chicago, president; Col. J. R. Gilmore, of New York, vice-president, and J. E. Pettit, of Chicago, secretary and treasurer. After some desultory discussion and exchange of opinions and views, the convention adjourned to give the members an opportunity to attend the banquet, and, notwithstanding the heavy rain, the trip to Coney Island was an enjoyable one. Around the festive board in the Manhattan Beach hotel were seated fully 150 military telegraphers and old timers. Appropriate remarks were made by President Plum, James D. Reid, Thos. P. Scully and others, and toasts drank. A safe return to the Murray Hill hotel was effected at 1 A. M., by a special train, after an evening of thorough enjoyment.

Promptly at 10 A. M. on the following day, August 20, the meeting of the Old Timers was rapped to order by president C. W. Hammond, of St. Louis, who delivered an interesting address. Seventy-three new members were then elected—a suggestive number, as remarked W. J. Dealy. A communication and a photograph of James Leonard, from Chas. E. Taylor, of Frankfort, Ky., were placed, by vote, among the archives of the association. The treasurer's report showed a balance of $76.65 on hand. Old time reminiscence was then for some time indulged in by Mr. David Brooks and others, after which the convention adjourned to the steamer "Sylvan Dell," in the cabin of which a joint meeting was held, and many interesting communications read, including a poem by George Walcott, of New York. Mr. James D. Reid was unanimously and enthusiastically elected president by acclamation. Mr. C. S. Jones, of Chicago, was made vice-president, and W. J. Dealy, of New York, secretary. Votes of thanks to the retiring officers and to the New York committee of arrangements were passed. Cleveland, Ohio, was selected as the place for the next meeting. The association appropriated $25 towards the erection of a monument to the memory of James Leonard, to be situated at Frankfort, Ky. Mr. C. C. Hine, of New York, gave $25 for the same purpose, and other contributions were offered. The constitution was changed to qualify for membership any person in the business 20 years, of which time at least one year must have been devoted to manipulating the key. All points of interest on the East and North rivers and in the bay, including the Statue of Liberty, Riverside park, Governor's, Blackwell's and other islands, were visited. Commodore Wiman was on board, and personally looked after the comfort of his guests, who had now swelled to almost 500 happy old timers. Never was such a large gathering of prominent electrical men held, and the best of feeling prevailed throughout, and a hearty vote of thanks was given the commodore for his kind treatment. The delegates left for their homes the following day, taking with them the kindest remembrances of the generous hospitalities extended to them by the New Yorkers.

The next reunion of the organizations will be held at Cleveland, Ohio, beginning on the third Wednesday of August, 1886.

The following is a partial list of the gentlemen present, many of whom were accompanied by their wives, daughters, and lady friends, composing as bright and well-appearing an assemblage as can be brought together:

Atwell, J. W., Chicago, Ill.
Adkins, George, N. Y.
Brooks, David, Philadelphia.
Bradnack, Dr. Fowler, N. Y.
Burnett, Geo. A., Buffalo.
Buehler, Rich'd E., Greenville, Mo.
Bruner, Phil., Wellesville, O.
Burch, Chas. B., Chicago.
Barth, Martin, Gallatin, Tenn.
Bunnell, J. H., N. Y.
Bliss, A. H., Chicago.
Bates, D. H., N. Y.
Brant John, N. Y.
Brown, A. S., N. Y.
Bresee, H. Y., Binghamton, N. Y.
Chamberlain, H. B., Denver, Col.
Crittenden, J., Newton, Chicago, Ill.
Duncan, F. H., Trenton, N. J.
Dealy, W. J., N. Y.
Doolittle, H. E., Lafayette, Ind.
Dugan, Geo. M., Jackson, Tenn.
Duncan, Frank, Pittsburg, Pa.
Dwight, J. H., N. Y.
Eddy, Chas. G., N. Y.
Edwards, J. L., N. Y.
Emerick, J. H., N. Y.
Fairchild, S. B., St. Louis.
Fullen, T. F., N. Y.
Finnegan, T., N. Y.
Goolding, Geo. J., Erie, Pa.
Gilmore, B. F., Chambersburg, Pa.
Gilmore, Col. J. R., N. Y.
Gemmall, R. B., Topeka, Kan.
Hall, H. H., Ashtabula, O.
Hine, C. C., N. Y.
Hueston, J. C., N. Y.
Hamilton, Geo. A., N. Y.
Hinchman, J. C., N. Y.
Hammond, C. W., St. Louis.
Hemmens, John, N. Y.
Ives, W. L., N. Y.
Jaques, C. W., Ashtabula, O.
Johnston, W. J., N. Y.
Jones, C. S., Chicago.
Jones. Lant S., N. Y.
Jones, F. W., N. Y.
Knittle, Joseph, Brooklyn.
Knapp, S. B., Passillon, Neb.
Knight, F. B., N. Y.
Kerner, M. H., N. Y.
Lyons, Geo. M., Titusville, Pa.
Ludwig, John F., Burlington, Ia.
Lithgow, Hec., Kansas City, Mo.
Logue, W. S., Baltimore.
Long, W. C., Chicago.
Leslie, E. A., N. Y.
Lines, R. B., Washington, D. C.
Ludwig, D. J., N. Y.
Murray, P. J., Jackson, Tenn.
Maynard, Geo. C., Washington, D. C.
Merrihew, James, N. Y.
McReynolds, C. D., Denver, Col.
McCluer, C. C., Richmond.
Maize, I. D., Philadelphia.
Mattoon, John, Cincinnati, O.
O'Brien, Richard, Scranton, Pa.
O'Brien, John E., Scranton, Pa.
Orton, A. W., Rome, N. Y.
Parker, L. D., Chicago, Ill.
Phillips, Walter P., N. Y.
Palmer, Sol., St. Louis.
Parsons, John W., Springfield, O.
Plum, H. W., Chicago.
Plum, W. R., Chicago.
Pettit, J. E., Chicago.
Reid, Jas. D., N. Y.
Rosewater, E., Omaha.
Rose, L. A., Carbondale, Pa.
Ryan, Crosby J., Detroit.
Royce, Fred. W., Washington, D. C.
Redding, M. H., N. Y.
Sargent, W. D., Brooklyn.
Sheldon, L. F., Sedalia, Mo.
Schnell, Jos., Binghamton, N. Y.
Somerville, W. B., N. Y.
Schermerhorn, Ed., Omaha.
Scully, Thos. P., N. Y.
Stephenson, R. G., N. Y.
Smith, C. T., N. Y.
Smith, Richmond, N. Y.
Swayne, Wager, N. Y.
Shaw, John B., Jamestown, N. Y.
Safford, A. G., Burlington, Vt.
Van Duzer, Col. J. C., Escanaba, Mich.
Van Horn, John, N. Y.
Wilson, W. B., Philadelphia, Pa.
Wickham, John J., Beaver, Pa.
Whitford, E. P., Chicago.
Waters, H. S., Chicago.
Ward, H. H., N. Y.
Williams, Thos. G., Pittsburg.
Wiman, Com. Erastus, N. Y.
Winthrup, J. W., Philadelphia.
Yeakle, J. B., Baltimore.

THE BATES-FIELD-GARRETT-GREEN-PENDER CORRESPONDENCE.

The daily papers during the past month have been well supplied with copies of letters and telegrams, the object of which was to show whether Mr. Garrett did or did not make overtures for either an amalgamation or pooling arrangement between the rival telegraph companies.

In connection with this subject, the following extract from the Baltimore correspondence of the *Maryland Journal* will be found of interest.

BALTIMORE, August 21, 1885.

The commercial and business mind of Baltimore continues to be considerably exercised concerning Mr. Robert Garrett's recent tournament with Jay Gould, Russell Sage, Cyrus W. Field, and other money kings. The latter gentlemen of unblemished virtue and unimpeachable veracity, have been earnestly laboring together in an endeavor to prove that Mr. Garrett has offered to sell them the Baltimore and Ohio telegraph lines, for consolidation with the Western Union system. Mr. Garrett positively denies this, and therefore leaves floating around a lie of large magnitude, without any accurately defined paternity—an orphan lie, so to speak. While it would be difficult to assign any valid reason against Mr. Garrett's assertion, it is easy enough to see abundant cause for the action of the New York bandits. They are virtual owners of the Western Union, and have "watered" its stock up to the enormous sum of $80,000,000, while the actual value of their entire stock in trade is not one-fourth of that amount. Until the Baltimore and Ohio lines were established the Western Union held a practical monopoly of telegraph business in the entire country, having absorbed all lesser lines necessary to its vast connections. But the Baltimore and Ohio system has grown to be a dangerous rival, and has forced the Western Union to such a large reduction of rates as to prevent payment of dividends on its $80,000,000 of stock. As a consequence, Gould and his brother robbers find that they can save the life of their swindle in no other way than by getting possession of the Garrett line.

To attain such a vitally important end they will not hesitate at any needful amount of lying; and it is safe to assert that the present dispute as to veracity is due entirely to a fear of probable bankruptcy on the part of the Western Union. But, whatever be the cause, the imbroglio has had the excellent effect of opening the eyes of our people to the perilous magnitude of the operations in which the Baltimore and Ohio company is engaged out-

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side of its legitimate railroad business. The state and city are large holders of the stock, and the subject is, therefore, of general public concern; but it is an open fact that our Baltimore newspapers have continually refrained from critical comment on the acts of the road's managers. In fact, since the passage of the Stockholder Direction bill, some 25 years ago, the company has been practically "a close corporation." State and city directors have been regularly appointed, but they may as well be wooden men for all they were permitted to know of the real operations of the direction. Once a year the stockholders and the general public have been given a report of the road's affairs, and the figures thereof were large exponents of increased traffic and corresponding profits. But the state, city, nor individual stockholders were never seriously consulted about the institution of a telegraph company, an express company, or the extension to New York by which Baltimore is to be made a way station. The unwisdom of this extension is generally confessed, chiefly on the ground that there can be no profit in its competition with a near and parallel railroad. The express business has no doubt been profitable, because its equipment was of but little cost to the railroad company. But the telegraph plant is a very different matter. Its cost has been enormous, and it is said that its receipts do not pay current expenses.

All this may or may not be true; but there certainly begins to be seriously agitated an inquiry as to the *right* of the directors to use the company's resources and credit for the purpose of antagonizing the Pennsylvania Railroad, Adams' Express Company, and the Western Union Telegraph. Perhaps the subject would not have been brought into discussion but for the fact that the question of veracity between Mr. Garrett and the Jay Gould bandits has given opportunity for statements which, whether true or false, are calculated to depreciate the value of the B. & O. stock, that for years has stood at so high a premium as to keep it out of the market. Naturally enough, the holders of it must be alarmed at Jay Gould's assertion that the B. & O. Telegraph is losing $500,000 per year, and that the company is heavily indebted to New York and New England banks. And this healthy alarm will probably be of benefit if it result in a combination of stockholders to compel the railroad direction to confine itself to the business for which it was incorporated.

SUBTERRANEAN PLANS SUBMITTED TO THE COMMISSION ON ELECTRIC SUBWAYS.

It was announced that August 13th would be the last day allowed for the filing of plans by the various electrical companies for future subterranean work. Nothing of a definite character was received, although promises were made to submit plans in the future. A large number of communications have been received from inventors and companies controlling patents for constructing a system of underground wires, and these have all been laid over for future consideration.

A communication was received from the New York Electric Lines Company submitting a plan for a trunk line of underground wires, to consist of four cast iron pipes running side by side, and intended to accommodate in one system all the wires of the companies doing business in this city.

The Hussey Electric Light and Power Company also submitted plans and a map of the system on which it is working, by which portions of the wires are laid underground and the rest on the face of the curb or along the angle formed by the curb and the pavement. Among other systems presented at subsequent sessions of the commissioners were the following:

The Universal Insulating Co. of Paterson, N. J., submitted a cheap insulating material for wires.

The Commercial Cable Co. described the plan adopted by it as a gutta-percha cable, drawn through an ordinary cast-iron pipe placed three feet below the surface. In the upper part of the city no pipe was used, the cable being protected by blue-stone flagging placed over it.

The Averell company sought information regarding the number of wires to be placed underground, in order that they might prepare maps and plans. The Department of Public Works was instructed to furnish such details as might be in their possession.

Mr. Heylyn submitted a sample of concrete composed of rosin, plaster-of-paris, sand, and oil residuum, of which he proposed to build a conduit of any pattern required. He was requested to furnish a model, which he agreed to do.

B. F. Carpenter, of Roselle, N. J., submitted drawings and description of an underground pipe or conduit three feet in diameter, with brackets along the sides and a railway on the bottom, upon which a lineman makes his tour in a reclining chair fitted with wheels.

George W. Mowbray presented samples of his insulated wire, the rubber used in its covering being mixed with naphthaline during manufacture, which subsequently evaporates, leaving the gum in a pure state. He stated that 1¾ miles had been placed underground for telephone purposes in Boston, of which a report had been promised, but not yet received by him. He proposed to bundle all the wires together, and could place 600 telephone wires in a space 5x2 inches.

Harry E. Dey, of 96 Grand street, announced that he had a system by which he could lay down 600 feet of conduit per day, without regard to the number of wires. No induction would be felt on account of the distance between the wires. No exhibit was made.

C. C. Gilman, No. 1 Broadway, N. Y., explained his drawings as representing a conduit 6x8½ feet, built of terra-cotta lumber, soaked in asphaltum, the walls to be 12 inches thick. This material can be tapped at any point. Its cost would vary from $65,000 to $105,000 per mile, according to size, and the branches about $5 per foot.

Ranald Macdonald is a believer in pine lumber. He proposed to embed the wires in well-seasoned pine boards, tongued, grooved and fitted closely, saturated in paraffine and coated with tar, then sheathed with copper, and encased outside with plank. He submitted a sample section.

J. J. C. Smith, from the Okonite Co., opened by announcing that physicians pronounced conduits unhealthy, and showed a sample of armored cable which may be buried just beneath the surface. The ends of the cables are brought to joint boxes at the street corners, inside which cross connections can be made with the side streets as required by the use of flexible conducting cords. One mile of cable containing 100 No. 16 wires may be put down for $10,000. Smaller cables are led from the joint boxes to the corner building, and thence along the block to each house.

The American Underground Electric Wire Co. submitted a model of a conduit, to be made of any suitable material. They recommend an artificial stone. This conduit may be from three to six feet in height. Brackets are provided on each side for telegraph and telephone wires, the electric light wires being placed below all, and protected by a sectional false bottom. The insulation furnished for wires is also included in this plan, which is called the Howe system. It was stated that insulation is so perfect that *inductive effects cannot be felt through it* when a telephone wire is wrapped spirally around 2200 feet of an arc lamp circuit.

The commission has engaged rooms at 23 West 23d street, where the sessions will be held hereafter.

A TELEPHONE DEAL LEADS TO MURDER.

The city of Lawrence, Mass., was the scene of an apparently deliberate murder on August 27, both parties being well-known citizens who had been intimately associated with each other in the telephone business. Henry K. Goodwin, at ten o'clock on the morning of that day, called upon Albert D. Swan at his office, where they engaged in conversation regarding previous business transactions. The bookkeeper in the adjoining room was soon after startled by the sound of a pistol shot, and turning quickly saw Mr. Swan reel and clutch the corner of his desk, with blood spurting from a wound in the back of his head. He fell to the floor and died in a few moments. Goodwin, who had deliberately shot him with a 32-calibre revolver, walked over to the telephone, notified the police that he had committed the deed, and offered to deliver himself up. He then walked to the station, where he stated that Swan had robbed him of all he possessed; that there was a period in a man's life when he could stand no more, and that he had reached that point. During the half hour's discussion he said Swan had laughed at him, and he was wrought up to such a state of desperation that he fired the fatal shot, and was ready to abide by the consequences.

Mr. Goodwin was one of the pioneers in the telephone business, which he embarked in as a member of the firm of Goodwin & Caldwell. Selling out to Swan and his partner, he went to Buenos Ayres in charge of the Bell telephone system there. Returning two years ago he entered the employ of the Molecular company. He is a native of Lawrence, where he has a family, and is about 38 years of age.

Albert D. Swan was a native of Tewksbury, Mass., where he was born in 1845. He was for many years in the insurance business, and subsequently became interested in telephone shares, thereby accumulating a fortune. It is said that he agreed to aid Goodwin financially in securing the patent for a switchboard, but neglected to pay the final fee. Meanwhile a patent was issued to Waite & Bartlett covering substantially the same ground. A joint arrangement was finally entered into to harmonize the conflicting interests, but Goodwin's friends assert that he might have made $40,000 out of the invention had it not been for Swan's carelessness.

Goodwin had just returned from a three weeks' trip in search of employment, but was unsuccessful. The defense is expected to be based on insanity.

STORAGE BATTERIES FOR A RAILWAY MOTOR.

An apparently successful test of the availability of an electric storage battery as a motive power for street passenger railways, took place recently upon the Union Passenger Railway from the

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stables on Huntingdon avenue to Hampden, Baltimore county, Maryland. There were present upon the trial trip Messrs. A. G. Davis, A. B. Davis and A. B. Proal, representing the Viaduct M'f'g Co's establishment at the Relay Station, Baltimore and Ohio Railroad, a large portion of which was built for the manufacture of electric storage batteries, and the batteries used upon the above occasion were made by them; Mr. James R. Clarke, president of the company; Mr. A. H. Bauer, the electrician of the company, under whose direction the practical test was accomplished; Mr. W. W. Donaldson, assistant electrician; Mr. H. A. Foster, the electrician for the Daft Electric Company of New York, whose motor was used in connection with the storage battery; Mr. T. C. Robbins, superintendent of the railway company, who allowed the use of his motor, tracks and cars for the experiment. Eighteen persons were in the car, which, with the weight of the car, motor, &c., made a total of five and one-half tons. The car moved out of the yard, passing over grades of 235 feet to the mile and around curves with 75 feet radius with ease and comfort. The batteries used on the occasion were simply one-quarter h. p., not even made for motive power, but for incandescent lighting, but Mr. Bauer, the electrician, after figuring out the subject, decided that even with these small boxes a street car could be run, as was fully demonstrated. Forty-nine of the little one-quarter h. p. boxes were placed in the cab and connected with the Daft electric motor. On level grades only 20 of these boxes were used, the loaded car making easily six miles an hour. On the 235 feet grade the 49 boxes were used, equal to eight 6-10 h. p.

A storage battery especially constructed for street car purposes would consist of one h. p. boxes instead of one-quarter, and about 65 would be required. The storage company simply placed their small boxes in the motor car used by the Daft company. In practical usage these boxes will be put under the seats of the ordinary passenger car. The car will be started or stopped by simply turning a switch. An ordinary hand brake was used, though this work in future will be done by electricity.

"THE BEST LIGHTED CITY IN THE WORLD."

DETROIT STREETS.

Detroit has no street signs—that is, no signs with the names of the streets painted upon them. But Detroit has signs of streets. A rough, rotting, unrepaired pavement full of holes, such as jars and rattles the life out of a fine carriage to go over it faster than a walk, is a certain sign of a Detroit street. A lake of thin, slippery mud, caused by excessive sprinkling, sending up a continual steam of disease-breeding reek, spoiling the bottoms of ladies' dresses and covering the polished shoes of gentlemen with filth, is a sure sign of a Detroit street. A driveway, nearly half of which is obstructed by piles of brick and building material, and half of the rest by loading and unloading wagons, is another sign of a Detroit street. A passage for teams where everybody digs up the pavement at pleasure to fix a gas or water pipe and puts it down again so as to leave either a hillock or a hole, is another sign of a Detroit street. Utter darkness o' nights for two to four blocks, with nobody knows how many holes, piles of rubbish, or other obstructions there may be in the way, so that he has to depend solely upon the intelligence of his horse, is a very common sign of Detroit streets. And, finally, to meet with a lost stranger every two or three blocks, who stops one to inquire his way, is another continual sign of Detroit streets.—*Detroit Post*, Aug. 20.

ELECTRIC MOTORS IN MARYLAND.

The prudent and conservative city folks are anxious to have a substitute for horse and mule power on their street railways. The electric motors fill the bill exactly; but the timid Baltimoreans want them tried first on "some other fellow," and have generously and humanely selected country people as the other fellow. If the experiment succeeds it will be bravely adopted within Mayor Latrobe's jurisdiction. And if it proves disastrous to life or limb, "it will just serve the Belt people right for refusing to be annexed" to the joys and beauties of city taxation.

But the motor does seem to be a success—barring some shocking objections on the part of horses that have not yet learned all about the powerful ability of "the middle rail." Last Tuesday two of the motors ran for the first time on schedule all day from Huntingdon avenue stables to the terminus of the Union Line at Hampton village, making the round trip of four miles in 40 minutes without interruption or accident—the time being fully one-third less than by mule power. At each country road crossing a man is constantly on hand to prevent accidents to quadrupeds and to give warning to ignorant persons who may stray outside the city limits.—*Maryland Journal*, Aug. 22.

EFFECTS OF LIGHTNING IN CONNECTICUT.

The Norwich *Bulletin* gives the following account of the visitation of a thunderstorm August 25, which, it says, came down upon the city with a show of electricity and crash of thunder never experienced in that section. The lightning was almost continuous, and the successive thunder peals deafening. Wherever there were metal pipes or sinks the electricity seemed to play and snap and sizzle in a way that shocked the nerves of the timid. At one flash all the electric lights in the city were instantaneously extinguished, and the armature of one of the dynamos in the office of the electric light company was burned out and temporarily thrown out of use. Several stores using the electric light dismissed their clerks and closed their doors for the night. In the same shower the fire alarm telegraph system was thrown out of use, and several of the telephone circuits were burned out. There had been a steady rain all day.

THE DAFT MOTOR PLACED ON THE ELEVATED RAILWAY.

The electric motor "Benjamin Franklin" constructed by the Daft company has been placed on the track of the Ninth avenue elevated railway. The third line of rail which had been laid for some weeks, was found to have become quite rusty, therefore the first work of the motor was a trip over the route Wednesday night, with a grinding attachment in order to brighten the rails with which electrical connection is made. It was expected that everything would be in readiness for a public trial of the system on Monday, August 31, just after this issue has gone to press.

THE TELEPHONE CONVENTION AND RHODE ISLAND CLAM-BAKE.

The annual convention of telephone delegates will be held at Providence on September 8th. It is expected to be an unusually large meeting, followed closely as it is to be on September 11th, by the seventh annual gathering of electrical representatives of every description, without regard to age, sex, race, or previous condition of servitude, as the guests of Eugene L. Philips, on the romantic shore of Narragansett Bay.

ELECTRIC LIGHT AND POWER.

The Schuyler Electric Light Co. has secured the contract of lighting the streets of Richmond, Va., for five years, also the exclusive privilege of supplying light and power to private consumers, during the same period. Two hundred arc and 1,000 incandescent lamps will be required to begin operations. The city owns the gas works.

A corporation under the general laws of the state has been organized in Manchester, N. H., under the name of the "Forsaith Electrical Machine Co.," for the manufacture of dynamos, under the Whitney patent. The capital stock is $60,000 in shares of $100 each.

One of the largest single electric lights ever constructed was placed on exhibition at Seneca Falls, N. Y., on a recent Saturday evening. It is of 50,000 candle power, and is placed on the tower of a building at a height of 75 feet from the ground. It was intended to illuminate the whole village, but has not proved a success,

A company has been organized to establish, at Fenelon Falls, Ont., a power electric light plant, and by means of suitable wires serve the district within a radius of 30 miles.

The Electric Headlight Works, at Cuyahoga Falls, O., is about to ship ten outfits for use on the Northern Pacific Railway.

The Montezuma hotel, at Hot Springs, N. M., was destroyed by fire August 8th, the alarm being sounded at 11:30 P. M. By means of the electric gongs in each room, the 75 guests were immediately aroused and escaped. The building was lighted exclusively by the United States incandescent system. It was reported during the excitement that the building took fire from the wires, but there is no evidence that such was the case. The loss is placed at $300,000, insured for $250,000.

ELECTIONS AND APPOINTMENTS.

At the annual meeting of the Erie Telephone Co., recently held at Albany, N. Y., the following officers were chosen: James W. Bennett, president, Charles J. Glidden, secretary and treasurer, J. P. McKinstry, general superintendent, Charles A. Grant, transfer clerk.

MANUFACTURING AND TRADE NOTES.

Albert B. Herrick, manufacturer of electrical instruments in this city, assigned, August 17, to T. Frank Brownell. Liabilities about $3,500; assets, $1,500.

The Washburn & Moen Manufacturing Company, Worcester, has just finished the erection of a new foundry building, 100x 60, at Quinsigamond village, for the manufacture of steel for its own use.

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PERSONAL MENTION.

Professor Robert H. Thurston has resigned from the faculty of the Stevens Institute of Technology, having accepted the position of Director of the Sibley School of Mechanical Engineering and of Mechanic Arts, recently organized in connection with Cornell University.

The most extreme point in Arctic exploration must have been reached by Sir William Thomson when he painted the north pole red.

THE TELEGRAPH.

Joseph Harris, who was arrested for alleged connection with the Detroit bank robbery in 1880, was released at Chicago July 30, on a writ of habeas corpus by Judge Anthony, who held that there were no grounds for his arrest except on a telegram, whereas an affidavit was necessary.

It was discovered at Conshohocken, Pa., July 30, that three unknown thieves had mounted the telegraph poles from West Conshohocken to Bala station, a distance of seven and a half miles, and had stripped and stolen two lines of copper telegraph wire of the Postal Telegraph Company. The total length of wire stolen is 15 miles, weight nearly a ton, and value $500. The thieves operated in broad daylight, passing along the road in a wagon, removing the wire and acting as if they were authorized employés.

Justice McCartney has filed a suit for $4,104 at Washington, D. C. against the Western Union Telegraph Co. Plaintiff was proposing to bid for the erection of a Government building at Terre Haute, Ind., and, on October 30, 1884, telegraphed A. B. Fitch there to know the price of brick and sand, that he (McCartney) might be guarded in making his proposal, notifying the company that, as the business was important, to hold the answer at the office, and he would call for it. He states that the answer was received the next day before one o'clock, but on calling for it he was informed that no answer had been received, that he made a similar inquiry a half hour later and learned the answer had been sent to his residence, and, driving thereto, found the telegram had been delivered. The bids were received at the Supervising Architect's office, at the Treasury, at two o'clock, and proceeding directly there, after obtaining the telegram, and putting in his bid, he was told that the time for receiving the bids had expired, and his proposal was refused. He states that his bid was for $200,600, and was the lowest, and would have been accepted if presented in time. He avers that by the carelessness of the company he has suffered loss as claimed.

THE TELEPHONE.

A telephone company may be held liable for an injury to a passer-by by the fall of its wires in a public street, caused by the weight of ice produced by water thrown over them by a city fire department while extinguishing a fire, according to the decision of the Supreme Court of Minnesota, in the case of Nichols vs. City of Minneapolis, decided on the 9th ult. Where such a company is given a license to string its wires over the public street, it is, in the opinion of the court, burdened with the duty of maintaining those wires in a safe condition, so that they may not become nuisances or endanger the safety of the traveling public.

The telephone subscribers in western Massachusetts, are said to be considerably irritated, because their yearly rentals have recently been increased. Many of them will doubtless discontinue.

The Lalande-Chaperon (oxide of copper) battery has been adopted for exchange and line service by the Société Générale des Téléphones of Paris.

In an action in the circuit court of Charleston, S. C., for $5,000 damages against a telephone company for cutting the telephone wire of a subscriber during the existence of a contract with the company, the jury found a verdict for the plaintiff for $1 and costs. The judge charged the jury that under the contract the plaintiff had no right to allow non-subscribers to use his telephone, but the company had no right to cut his wire until it had forbidden such a practice in writing. If the offense continued after such a notice the company had the right to cut the wire, but if not continued it had no right to do so upon a mere threat of the plaintiff that he would continue to violate the contract.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 11 Wall Street, *New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From July 7th to August 11th, 1885 (inclusive).

Alarms and Signals:—*Signal Apparatus*, M. W. and M. F. Parrish, 322,474, July 21. *Indicating Apparatus*, M. W. Grovesteen, 322,818. *Indicator for Bell Circuits*, W. A. Leipner and C. Brotherhood, 322,619. *Letter Box Alarm*, C. S. Ellis, 323,129, July 28. *Fire Alarm Box*, F. F. Loomis, 323,485, August 4. *Low-Water Alarm*, W. P. Ryman, 323,600. *Window Screen Alarm*, H. Garrett, 324,019, Aug. 11. *Annunciator*, C. E. Dey, 323,921.

Clocks:—*Alarm Clock*, C. Korfhage, 322,110, July 14. *Sparkless Circuit Breaker*, L. H. Spellier, 322,494, July 21.

Commutators:—*Switch*, E. Thompson, 321,462. July 7; F. Schaefer, 322,857, July 21; E. B. Nicolaus, 322,745; Leo Daft, 322,915, 322,916, July 28; H. K. Goodwin, 324,248, Aug. 11. *Spring Jack Switch*, J. C. Warner, 321,553, July 7. *Switch Board*, A. C. Mather, 323,182, July 28.

Conductors, Insulators, Supports and Systems:—*Underground Conduit*, J. Teggart, 321,865, July 7; W. D. B. Smith and F. J. Milliken, 322,018, July 14; D. H. Dorsett, 322,529, July 21; W. Walter, 323,241, July 28; W. B. Rogers, 323,964, Aug. 11. *Insulator*, E. T. Schoonmaker, 321,646, July 7. *Composition for Insulating Wires*, J. W. Ellis, 321,956, July 14. *System of Electric Distribution*. E. Thomson, 322,138, 322,139. *Conducting System*, John Kruesi, 322,385. *Tubular Cable*, P. Sorgue, 322,493, July 21. *Process of Making Kerite*, A. G. Day, 322,802, 322,803, 322,804, 322,805. *Rubber Compound*, L. S. Hoyt, 322,936, July 28. *Circuit Controller*, D. Rosseau, 322,973. *Insulator*, T. McGlory, 323,055. *Conductor*, R. A. Denison, 323,920. *Suspended Electrical Conveyor*, C. J. Van Depoele, 323,984, Aug. 11. *Cable Support*, E. M. Carhart, 324,225. *Method of Forming Screw Threads on Glass*, J. G. Pennycuick, 3.4,157. *Metal Tipped Cord*, W. H. Sawyer, 324,171.

Dynamo Machines and Motors:—*Dynamo*, E. J. Leads, 321,609, July 7; E. R. Whitney, 322,230, July 14; C. F. Ruset (deceased), 322,310; L. Bollmann, 323,108, July 28; E. Thomson, 323,975, Aug. 11; J. J. Bradley, 324,075. *Device to Prevent Sparking in Dynamo*, R. H. Mather, 321,990, July 14. *Support for Armatures of Dynamo*, same, 321,991. *Reciprocating Motor*, E. Knabe, Jr., 322,296. *Regulator for Dynamo*, R. R. Moffatt, 323,059, July 28. *Commutator for*, B. F. Orton, 323,361. *Armature for*, same, 323,362, 323,363. *Motor*, F. J. Sprague, 323,460; M. G. Farmer, 323,652, 323,653, Aug. 4; C. J. Van Depoele, 323,982, Aug. 11. *Vibrating Motor*, A. L. Parcelle, 324,152. *Cut-Out for Dynamo*, C. J. Van Depoele, 323,470, Aug. 4. *Regulator for Motor*, M. G. Farmer, 323,650. *Automatic Commutator Adjuster for Dynamo*, E. Thomson, 323,976, Aug. 11.

Electrolysis.—*Manufacture of Methylene Blue*, 323,514, Aug. 4.

Galvanic Batteries:—C. P. Orne, 321,446, July 7; E. T. Starr, 321,917; H. J. Brewer, 323,902, 323,903, 323,904, 323,905, Aug. 11.

Ignition:—*Gas Lighting Apparatus*, H. N. Williams, 322,238, July 14; L. S. White, 324,058, Aug. 11. *Marine Torpedo*, A. Castro, 322,900, July 28. *Primer*, R. H. S. Thomson, 323,974, Aug. 11. *Portable Gas Lighting Apparatus*, C. L. Clarke, 324,009. *Spark Generator*, same, 324,010.

Lamps and Appurtenances:—*Regulator for Electric Lights*, W. J. Paine, 321,843, 321,844. *Method of Regulating same*, 321,749, 321,845, 321,846. *Lamp Holder*, A. H. Hathaway, 321,493, July 7. *Globe Support*, A. Bossard, 321,788. *Holder for Incandescent Lamps*, H. Pieper, 321,933; O. A. Moses, 322,744. July 21. *Process of Making Incandescents*, H. H. Grubbe, 323,319, July 28. *Carbon for Incandescent Lamps*, W. Stanley, Jr., and E. P. Thompson, 323,372, July 28. *Carbon Electrode for Lamps*, G. D. Burton, 322,895. *Manufacture of Carbons for Incandescents*, J. W. Swan, 322,993. *Method of Manufacturing Incandescent Lamps*, W. Holzer, 323,150; A. L. Reinmann, 323,205; O. A. Moses, 324,334, Aug. 11. *Furnace for Baking Incandescents*, C. Coultass, 323,500, Aug. 4. *Process of Making Incandescents*, C. J. Van Depoele, 324,193, Aug. 11. *Lamp Insulator*, J. R. Fletcher, 323,504, Aug. 4. *Multiplex Arc Lamp*, R. H. Mather, 323,516. *Chandelier*, R. F. Barnes, 323,635. *Regulator for Incandescent System*, C. J. Van Depoele, 323,981, Aug. 11. *Multiple Incandescent Lamp*, W. Stanley, Jr., 322,496, July 21. *Incandescent Lamp*, J. Van Gestel and C. F. Beck, 322,024, July 14; P. K. Stern, 322,498, July 21; C. J. Van Depoele, 323,983, Aug. 11; O. A. Moses, 324,038. *Arc Lamp*, C. F. Beck, 322,033, July 14; C. Lever, 322,115; J. E. L. and W. J. K. Clark and R. D. Bowman, 324,008, Aug. 11; E. B. Cutten, 324,305. *Apparatus for Suspending Arc Lamps*, J. Young, 322,515, July 21. *Arc Lamp Regulating Mechanism*, B. A. Fiske, 324,311, Aug. 11.

Measurement:—*Reflecting Galvanometer*, R. J. Pratt, 323,208, July 28.

Metallurgy:—*Refining Copper*, M. G. Farmer, 322,169, 322,170, July 14.

Miscellaneous:—*Means for Controlling Gas under Pressure*, J. W. Ells, 321,426, July 7. *Time Lock*, W. E. Peirce, 322,317, July 14. *Printing Press Feeder*, J. A. Wetmore, 322,335. *Incandescent Sign*, I. W. Heysinger, 322,375. *Thermostat*, C. E. Kells, Jr., 322,612, July 21. *Door Opener*, T. A. Casey, 322,681. *Machine for Making Lightning Rod Connections*, S. Bradley, 323,105, July 28. *Carbon Cutting Machine*, M. Eagan, 323,125. *Speed Register for Ship Logs*, B. Faymonville, 323,134. *Heating Apparatus*, M. G. Farmer, 323,651, Aug. 4. *Armature for Electro-Magnets*, J. F. Gilliland, 323,663. *Recording Weighing Scale*, E. R. Puffer, 323,885. *Locking and Unlocking Mechanism for Electric Locks*, C. H. Crockett and C. C. Allen, 323,918, Aug. 11.

Protectors.—*Electric Apparatus Protector*, T. N. Vail, 322,214, July 14. *Lightning Arrester*, G. W. Mingle, 323,822, Aug. 4.

Railways and Appliances:—*Railway*, E. W. Siemens, 321,984, July 7; 322,859, July 21; 324,176, Aug. 11; E. M. Bentley, 322,517, July 21; O. Gassett, 323,138, July 28; F. J. Sprague, 323,459, Aug. 4; J. M. Pendleton, 323,199, July 28. *Railway Signal*, A. G. Warren, 323,243. *Grip for Railway*, J. C. Henderson, 323,675, Aug. 4.

Storage Batteries:—J. S. Sellon, 321,759, July 7; E. T. and E. E. Starr, 323,890, Aug. 4.

Telegraphs:—*Printing Telegraph Transmitter*, G. B. Scott, 321,858, July 7; *Synchronous Telegraphy*, P. B. Delany, 322,427, 322,688, 322,689, 322,690, 322,691, 322,692, 322,693, 322,694, 322,695, 322,696, 322,808, 322,809, July 21. *Quadruplex Telegraph*, L. O. McPherson, 322,739. *Duplex Telegraph*, L. A. McCarthy, 321,992, July 14. *Automatic Circuit Closer for Keys*, H. P. Thompson, 322,023, July 14, *Cable Recorder*, M. G. Farmer, 322,918, July 28, *Synchronous Movement*, A. L. Parcelle, 324,158, August 11.

Telephone Systems and Apparatus:—*Telephone*, J. H. Freeto, 321,960, July 14; J. E. Fuller, 322,884, July 21; C. L. Fortier, 323,311, July 28. *Switch*, T. J. Perrin, 322,122, July 14. *Acoustic Telephone*, Anthony Iske, 322,294. *Acoustic Diaphragm*, W. Jones and W. W. Reynolds, 322,295. *Means for Preventing Interference in Combined Telegraphic and Telephonic Systems*, F. Van Rysselberghe, 322,333, 323,239. *Apparatus for Suppressing Induction*, W. A. Jackson and J. C. Chambers, 322,724, 322,725, 322,726, 322,727, 322,728. *Signal Call for Telephone Offices*, A. H. Low, 322,835, July 21. *Telephone Circuit*, M. Brooks and H. R. Mason, 323,269, July 28. *Telephone Circuit and Apparatus*, T. N. Vail, 324,191, August 11. *Central and Subsidiary Exchange System Circuit and Apparatus*, same, 324,192.

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NEW YORK, OCTOBER, 1885.

THE STEARNS CONDENSER PATENT.

THE legal controversy which has been going on for some months between the Western Union and the Baltimore and Ohio Telegraph companies, has resulted in a victory for the latter, Judge Wallace having refused to grant the injunction asked for by the Western Union to restrain its rival from making use of the Stearns condenser in the operation of its duplex and quadruplex apparatus. Although it has attracted but little public attention, this case is in reality one of the most important ones in respect to the magnitude of the monetary interests involved, which has ever occupied the attention of the courts in the United States.

It was the application of the condenser by Joseph B. Stearns which first rendered it commercially practicable to operate long lines of telegraph, whether overland or submarine, by means of duplex telegraph apparatus. The United States patents for this invention were purchased by the Western Union Telegraph Company in 1873, and have unquestionably increased the value of its property to the extent of many millions of dollars. The patent was reissued in 1873, and again in 1882, the last reissue occurring about the time of the celebrated decision of the Supreme court in the case of *Miller* vs. *Bridgeport Brass Co.*, which laid down a radically new departure in respect to reissued patents. The ruling of the court in this case has since been followed with a strictness bordering on illiberality, and a considerable number of reissued patents which have come before the courts have been overthrown.

The counsel and experts of the Baltimore and Ohio company having advised it that in view of these decisions, the second reissue of the Stearns patent had in all probability rendered it invalid, under the present interpretation of the law, the bold move was made of applying the condenser to a large number of the main lines of the Baltimore and Ohio company, thus enabling it to quadruplex a large portion of its system and thereby enormously increase its carrying capacity. Suits were promptly instituted by the Western Union company and an application made for a preliminary injunction. Voluminous affidavits from nearly all the prominent experts in the country were filed on one side or the other, and some of the ablest counsel in the profession conducted the proceedings, among whom were Messrs. Dickerson, Duncan and Buckingham, for the Western Union, and Lowrey, Betts, Bacon and Hyde for the Baltimore and Ohio. The motion for injunction was heard before Judge Wallace, of the United States District Court, for the Southern District of New York, on September 2. Working models of the apparatus were set up in the court room, operated by the experts and explained to the judge by the counsel. The proceedings were of unusual interest, from a scientific as well as a legal point of view. The real point at issue was whether or not an attempt had been made, in reissuing the patent, to expand the claims so as to embrace a wider scope than those of the original patent.

Judge Wallace now decides that such is the case, or at least that the validity of the patent in its reissued form is not sufficiently free from doubt to justify him in granting a preliminary injunction. Had the injunction been granted, the consequences to the Baltimore and Ohio company would have been serious if not disastrous, as they would have been deprived of more than one-half of their telegraphic facilities terminating in New York city at a single blow.

The case will now proceed in the usual way to a final hearing on the merits, and the ultimate decision can hardly be reached under two or three years. There is little probability of any new evidence being forthcoming, not embodied in the affidavits already in the case, and hence there is no particular reason to anticipate a different decision even in the court of last resort. It is possible that the complainant may now reissue the patent once more, and restore it to its original form, abandoning the present proceeding and instituting a new one under the reissue, but in this event it could hardly hope to obtain a preliminary injunction, though it might have a better chance of success on final hearing than it now has.

This result is a substantial victory for the Baltimore and Ohio company, and very materially strengthens its position as a competitor of the Western Union company, for the general telegraphic business of the country. According to statements made in court, the profits of the Western Union have been disastrously affected by the competition which has only been rendered possible by the employment of this apparatus by its young and enterprising rival. If this is true, the outcome of the suit is a pretty serious matter for the Western Union.

THE INCANDESCENT LAMP TESTS AT PHILADELPHIA.

THE electrical exhibition held last year at Philadelphia, under the auspices of the Franklin Institute, was regarded as an especially important one by the electric lighting interests, largely in consequence of the extent and completeness of several of the exhibits of incandescent systems and apparatus. It was from the beginning the intention of the

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management of the Institute to avail itself of the opportunity afforded by the exhibition to institute a series of comparative tests, the results of which should be beyond criticism, and which should at the same time afford to purchasers of electric lighting plants accurate and reliable information in respect to the characteristic excellencies and defects of the different systems. From various unavoidable causes not necessary to particularize, it was found to be quite impossible to properly examine and test several of the largest and most important exhibits during the time of the exhibition. Soon after its close, however, the board of management of the Institute, appreciating the disappointment that would be felt by all persons interested in electrical progress, not merely in this country, but throughout the civilized world, if such a favorable opportunity were allowed to pass without contributing anything of value to the scanty stock of trustworthy data existing in relation to the actual economy and efficiency of incandescent lamps, passed a resolution directing the president to take the necessary steps to complete, in a satisfactory manner, the examination of the exhibits, and authorizing the expenditure necessary to be incurred in making the tests. A committee, consisting of Lieut. J. B. Murdock, U. S. N., Ensign Louis Duncan, Ph. D., U. S. N., Prof. W. D. Marks, of the University of Pennsylvania, and Geo. M. Ward, M. D., photometric expert of the Philadelphia gas works, were accordingly appointed to conduct examinations and tests of the efficiency and life of incandescent lamps.

The report of this committee, whose labors were continued for several months, has been awaited in electrical circles, with much interest, and has recently made its appearance. The report is quite voluminous and is somewhat too detailed for reproduction entire in the columns of this journal, but we have given elsewhere a sufficiently full abstract of its contents and of the results arrived at, to enable our readers to understand the valuable and important character of the work. We believe we do not err in expressing the opinion that the report of the committee is more exhaustive and complete than anything which has yet appeared in any part of the world in relation to the subject under discussion. The results of the tests of the life of lamps are of especial value from a commercial point of view; but many will share with us in the regret that through an unfortunate complication of circumstances, the tamadine lamps entered by Mr. Weston, although found during the preliminary trials to be defective were nevertheless under the rules subjected to a competitive test, in spite of his protest. We have no disposition to censure the members of the committee for their action in this matter, and indeed, it would seem that a strict compliance with the code of regulations by which the competitors had agreed in advance to abide, left the committee no alternative, when Mr. Edison's representative finally insisted that the tests should be proceeded with under the code. While it was clearly within his right to do this, and the incentive was particularly strong from a business point of view, still his action cannot but be regretted from a scientific standpoint, as it precluded the possibility of a satisfactory comparison between the two lamps, which are thus far the leading competitors in the United States. The results of such a comparison would obviously have been of greater actual value than any other point determined by the committee, but as it is, we are still without definite knowledge of the relative efficiency and economy of the lamps which are at the present time being put upon the market by the Edison and the United States electric lighting companies.

We have only space to call attention to a few of the many interesting facts disclosed by the tabulated results given in the report. The high efficiency claimed for the Woodhouse & Rawson (English) lamps, in tests reported from abroad, appears to be partially confirmed by the Philadelphia tests, which give for these lamps a mean efficiency of 204.9 spherical candles per electric horse power, being exceeded only by the Stanley-Thompson lamps which reached the high figure of 216.1 candles. The Edison lamps, while giving a comparatively low figure for efficiency, the mean being 169.2, surpassed all the others in length of life. A remarkable circumstance which is especially noticeable in the life tests, is the gradual falling off in efficiency, as shown by the diminution of the candle power, the Edison lamps declining fully one-half during the test of 1,000 hours, and many of the others in about the same proportion. In this respect the Weston 70 volt lamp made a comparatively good showing, as the tables indicate. From a practical point of view, the life of an incandescent lamp must be considered to be determined by the rapidity of this fall of efficiency, as it is of course necessary for the consumer to replace any lamp whose illuminating qualities have sensibly diminished, by a new one, without waiting for its actual extinction.

There is much in this report which merits careful study; and we have no doubt that the points we have suggested will receive due attention from our electricians.

The committee deserve high praise for the thoroughness, patience and evident impartiality with which they have performed their wearisome and somewhat thankless task, but we can assure them in behalf of the profession, that the value of their work is far from being unappreciated, and that its importance will come to be recognized more and more, as it receives careful criticism and consideration.

THE GOVERNMENT AND THE TELEPHONE PATENTS.

The announcement that a suit had been instituted by the law officers of the United States government, in the federal court at Memphis, to annul or set aside the Bell patent, has created a mild excitement in telephonic circles. The facts in the case appear to be substantially as follows: In October, 1883, an organization calling itself by the peculiar title of the Pan-Electric Telephone Company, was formed in Memphis, Tenn., with a capital of five million dollars, to exploit the inventions of one J. Harris Rogers. Four more or less prominent Tennessee politicians were associated with Rogers as incorporators, one of whom, Hon. A. H. Garland, afterwards became Attorney-General of the United States, and as it appears is still the owner of one-fifth of the capital stock. Several of the other incorporators also hold important offices under the present national administration. In July last, the American Bell Telephone Company made application to the United States circuit court, in the district of Maryland, for a preliminary injunction against the Pan-Electric and its local companies

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doing business in that state, and an order was issued to the defendants to appear on September 15, and show cause why a preliminary injunction should not be issued.

On August 29, certain parties in the interest of the Pan-Electric company petitioned U. S. District Attorney McCorey, of the western district of Tennessee, setting forth at great length that the Bell patents had been originally obtained by fraud in the patent office, and requesting him to report the matter to the department of justice, to the end that leave might be granted to him, in his official capacity, to institute suit against the owners of the Bell patents. The papers having been laid before Attorney-General Garland, leave was duly granted Mr. McCorey to institute proceedings in the name of the United States, and J. R. Beckwith, George Gantt, Casey Young and General Wright, all persons interested in the Pan-Electric and other rival telephone enterprises, were appointed special government counsel.

When the Pan-Electric injunction case came to be heard in Baltimore on September 15, before Justice Bond, the defendants' counsel endeavored to have the proceedings suspended to await the issue of the suit of the Attorney-General, but with only partial success. The court granted an order postponing the hearing until November 2, but meantime restraining the defendants from extending their business in any manner.

The bill filed by the Attorney-General contains all the familiar allegations which have been unsuccessfully put forth in prior suits, as to the anticipating inventions of Reis and others. The only new allegation is that of a fraudulent issue of the Bell patent, by the patent office.

It is very generally known that a caveat containing a full description of the electric speaking telephone was filed by Elisha Gray on the same day with Bell's application for a patent. The bill alleges that the contents of this caveat were wrongfully communicated to Bell by an official in the patent office, and that in view of the knowledge thus obtained, Bell subsequently amended his application, so as to claim the invention of Gray, which invention was not specified, claimed or described in his (Bell's) original application.

We do not know what proof the complainant may have, in respect to the malfeasance of the officials in the patent office, but the records show conclusively that the fifth claim of the Bell patent, the one which has been repeatedly sustained by the courts, was never amended, modified or changed in any way, from the time when it was sworn to by Bell, more than three weeks before the application was filed, until it was issued in the form in which it stands to-day, except by the insertion of the wholly immaterial words, "substantially as set forth." Even if it were true that Bell obtained a knowledge of the contents of Gray's caveat, he nevertheless did not alter or amend his application in consequence of this knowledge. Hence it would seem, that even were the fact of the unlawful disclosure of the caveat proven, the effect would be, not to annul the Bell patent, but at the furthest, to reinstate Gray's caveat, and institute regular interference proceedings in the patent office, so that Gray, in case he established his priority of invention by the necessary proof, might have a patent also, and thus be placed on an equal footing with Bell before the courts and the public.

It is hardly necessary to say that even the United States government has no power to annul or set aside a patent, except for good cause. We do not see that so far as disclosed, this action has anything material to support it, which has not already been passed upon by the courts, except the single allegation of the fraudulent amendment of the patent application, which an inspection of the records shows to be false. On the other hand, the personal interests of the Attorney-General are so clearly of a character to profit by the successful issue of such a suit, that an immediate and complete explanation would seem to be necessary to avoid a grave political scandal.

SUBTERRANEAN WORK IN BROOKLYN.

The electrical companies of New York city, who are looking to the investigations of the subway commissions, to devise plans by which they are expected to comply with the law, will find little information in the report of the Brooklyn commission. It is in the main confirmatory of the opinions of most practical men, whose experience had led them to believe that the original underground law was inoperative as well as unjust.

It takes the ground that it is not primarily the duty of the board to solve electrical problems for the benefit of the electrical companies, and that it is concerned in such questions only so far as they affect repairs or changes in the wires, which will involve the disturbance of the streets. Such being the admitted functions of the commission, its approval of the proposed plan as is described in the report is apparently open to criticism. No provision appears to have been made for electric light wires, and the structure itself can scarcely be considered of a permanent character. Modern public works embrace neither the pump-log aqueducts, nor the wooden sewers of past generations, and it is extremely doubtful if wooden pavements would meet with popular approval in some of our neighboring cities. The fact that the lumber is creosoted, while perhaps preserving the wood from decay, does not prevent the ingress of sand, water, sewer or illuminating gas, none of which should be admitted into what would be considered a perfect conduit. If the commission has no further power it should certainly prohibit temporary underground work, and if nothing better can be discovered than such an apology for a subway as is described it would be wise to permit the wires to be strung overhead for some time to come.

The time was rapidly approaching when the companies must have entered voluntary upon this work. Although a date was arbitrarily fixed for the enforcement of the law, it would have been far preferable to have extended the time than to permit the inauguration of a series of experiments which will involve not only the occasional digging up of the streets, but the eventual reconstruction of the entire system. Such a contingency should be avoided in this city. If a system cannot be secured that is permanent beyond question, affording facilities for electrical wires of every description, then its introduction should be deferred, rather than permit the annoyance which must arise from continual repairs, improvements and eventual abandonment of an untried invention.

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ARTICLES.

THE EFFICIENCY AND DURATION OF INCANDESCENT LAMPS.

THE special committee appointed by the Franklin Institute to conduct the tests of the incandescent lamps at the Electrical Exhibition has published a very complete report of its work from which the following extracts and tables are selected:

The scheme for a duration or life test of incandescent lamps was organized during the electrical exhibition by the executive committee. It had been recognized that tests of incandescent lamps for the determination of the efficiency alone afforded no data for deciding upon their relative value, the lifetime of the lamp being an important factor in the question of economy. A test which should furnish information on this point would be very valuable. Plans were early made for such a test, but as the time required was such that it could not be conducted by the photometric group of the board of examiners, it was placed in charge of a special committee, and invitations were extended to the principal incandescent light companies to enter their lamps. Before the necessary arrangements could be completed several of the members of the special committee were compelled by their engagements to leave Philadelphia.

The board of managers of the Franklin Institute thereupon placed the conduct of the tests in the hands of its president, who filled the vacancies existing in the committee, and authorized preparations for conducting the test on a larger scale than was possible during the continuance of the Electrical Exhibition. Three rooms in the exhibition building were set apart for the test.

A code had been prepared, specifying how the test should be conducted. This code was signed in December by Mr. Weston and Mr. Upton, representing the interests of the United States and the Edison companies. The Brush-Swan and the Bernstein companies declined to enter their lamps. The Franklin Institute entered a lot of Woodhouse and Rawson lamps, obtained from the Van de Poele Company, and also two grades of the Stanley-Thompson lamp, made by the Union Switch and Signal Company, of Pittsburg. The president of the Franklin Institute subsequently entered, for efficiency measurements, and for such a test of duration as circumstances would permit, a lot of Weston lamps (paper carbon), furnished by Mr. Weston; a lot of Woodhouse and Rawson lamps, received from the Edison Lamp Company, and a lot of White lamps, from the Electrical Supply Company.

In order to secure satisfactory results, and prevent needless discussion, the following code was agreed upon for the conduct of the test:

Proposed Code for Duration Test of Incandescent Lamps to be made by the FRANKLIN INSTITUTE *of the State of Pennsylvania.*

The parties hereto subscribing do agree to accept the services of the examiners herein named, and to abide by the method adopted for the test, and by the results obtained, without appeal.

NAMES OF EXAMINERS.

Lieut. J. B. MURDOCK, U. S. N.	Ensign L. DUNCAN, U. S. N.
Prof. WM. D. MARKS.	Dr. G. M. WARD.

Each company to enter twenty lamps. The examiners will select fifty lamps from a supply furnished by the companies, of not less than one hundred lamps. Twenty of these will be used in the preliminary adjustment of the circuit and then replaced at the beginning of the test by twenty similar ones, until then unused, save for preliminary determinations.

A preliminary test of each lamp under normal conditions will be made before the beginning of the continuous test, and the time used will be credited to each lamp.

This preliminary test will determine the spherical intensity of the illumination and the reduction factor.

The Franklin Institute shall have the right to enter lamps of different kinds for the test, such lamps to be treated in all respects as though entered by a competing company.

The difference of potential between the mains will be kept at 120 commercial volts. Weston's incandescent automatic regulator will be used, and no other adjustment of the potential of the mains will be attempted, save in the case of wide variation. A volt meter will be kept in circuit all the time.

A resistance of german-silver wire will be placed in circuit with each lamp, and a preliminary adjustment made, to give the lamp its proper difference of potential.

Exhibitors will give the potential required by their lamps. Unless the lamps are separately marked, all lamps of the exhibitor will be considered as exactly similar.

An Edison "T" dynamo, driven by a Porter-Allen engine, will be used. The circuit will be opened occasionally and the lamps allowed to cool.

Lamps shall be considered as out of the test when they fail to burn, whether due to breaking of glass or filament. When a lamp gives out it will be replaced by one requiring substantially the same difference of potential. The first three lamps of each company which are broken shall be replaced by others for which the preliminary measurements have been made, to be used only in case of accidental breakage.

The test may be declared ended at any time when in the opinion of the committee one system is so far in advance that a longer test could not change the result.

MEASUREMENTS.

Measurements of currents, difference of potential between terminals of lamp, and photometric intensity, will be made. The lamps will be arranged in a circle, having the photometer bar for a radius, and will be placed with the plane of the loop perpendicular to the bar. All measurements will be reduced to mean spherical intensity, by multiplying the intensity measured, by a reduction factor determined for each lamp. Photometric measurements will be made as necessary, but not oftener than once daily.

Electric measurements will be made daily.

A record will be kept of each lamp, in which all data relating to it will be entered.

Weekly reports will be made to the Franklin Institute, of the observations made, and showing how long each lamp has been under test.

METHODS.

The legal ohm will be considered the standard of resistance. The ampère will be determined by the silver voltameter, and checked by calculation of the constant of the current galvanometer used. The volt will be taken as that E. M. F. which produces a current of one ampère in a resistance of one legal ohm. The ampère equivalent of silver as determined by Lord Rayleigh will be accepted as correct.

Currents will be measured by a tangent galvanometer, the constant of which will be determined by the silver voltameter, and checked by calculation.

A standard resistance of german-silver wire wound on a reel will be carefully measured in turpentine or neutral oil, the temperature being observed. The potential galvanometer may be calibrated by connecting to the terminals of this resistance while a current simultaneously measured is passing through it. The temperature of the liquid will be observed and the resistance corrected therefor.

Calibrations will be made frequently during the test.

Potential may be measured by a mirror galvanometer in a shunt circuit of high resistance.

Each company will be permitted to have one authorized representative in attendance throughout the test, and every facility will be given to those representatives to inspect the working of the test that will not interfere with its progress.

The Franklin Institute agrees to keep the lamps under proper surveillance, and to take necessary precautions for their safety. Lamps accidentally broken will not be charged against the companies.

The right is reserved to discontinue the test at such times and for such periods as may seem advisable or necessary.

A preliminary test will be made before the actual test begins, to insure good working.

In case any objection be made, or difference of opinion should arise between the committee and the contestants, the unanimous vote of the committee shall be final.

If, however, there be not a unanimous vote, the minority of the committee shall appoint one referee and the majority another; these two shall appoint a third referee.

The decision of a majority of these referees shall be final.

(Signed) FRANCIS R. UPTON.
United States Electric Lighting Company,
per EDWARD WESTON, *Electrician.*

The test began with the following lamps entered:

20 Weston,	110½	volts.	Tamadine carbon.
20 Edison,	94–100	"	
10 Woodhouse & Rawson,	55	"	
10 Stanley-Thompson,	96	"	
10 " "	44	"	

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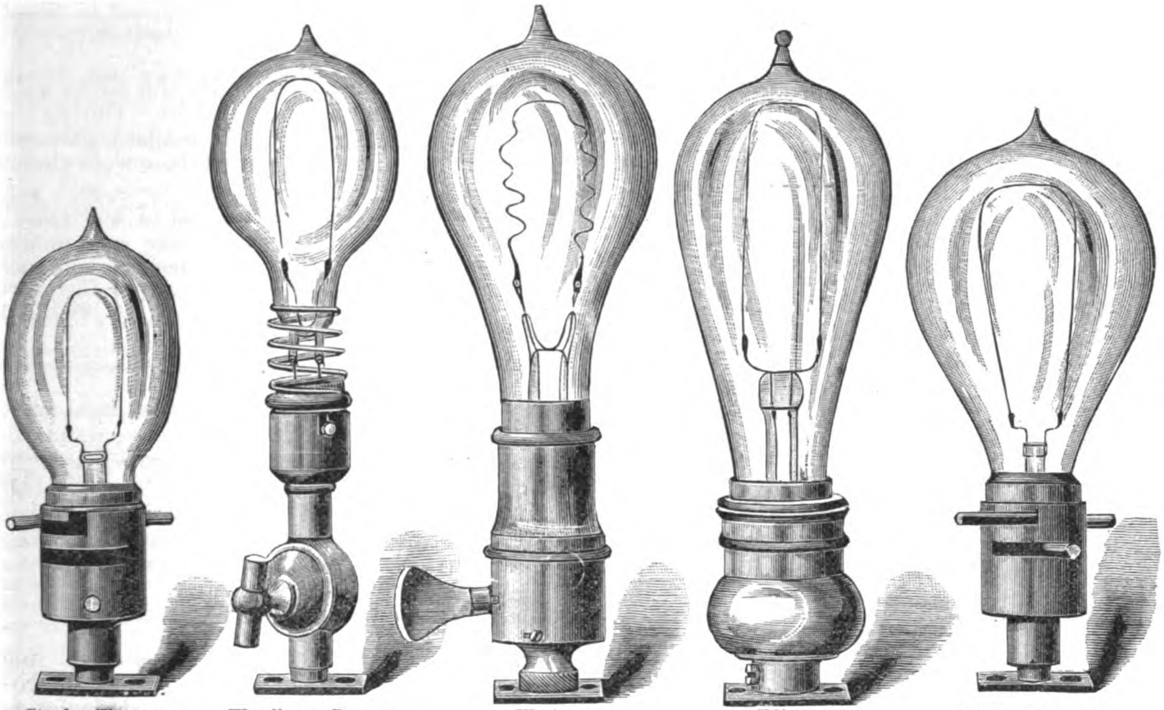
The latter lamps were requested to be entered at 16 c.p. The committee, after a preliminary trial of several of the lamps, fixed on the potentials of 96 and 44 volts, respectively, for the two grades, as approximately representing



Stanley-Thompson. (44 volt.) Woodhouse-Rawson. Weston. Edison. Stanley-Thompson. (96 volts.)

that candle power, and the lamps were entered at these potentials.

No official information was furnished the committee as to the process of manufacture of any of the lamps. Their general appearance and the relative size is shown in the cut.

PHOTOMETRIC MEASUREMENTS.

The measurements of the spherical illuminating power of the lamps were made with the object of obtaining the average candle power of the lamps, and to avoid the doubt as to the total amount of light which might arise from the various forms of carbon (many of them distorted in manufacture) used by different makers.

Sixty-five measurements or more were made on each lamp. The method pursued may be the more easily understood by a comparison with the parallels and meridians of the earth; referring to points by their latitude and longitude.

The lamp was placed in a vertical position, with the plane of the shanks of the carbon at right angles to the photometer bar. The side nearest the bar was marked for future reference. The top and bottom of the lamp were assumed as the north and south poles respectively, and the vertical circle at right angles to the plane of the shanks of the carbon as the prime meridian. The lamp, after adjustment as above, was first rotated horizontally, and 13 measurements were made in the equator at equal angles of 30 degrees, the last checking on the first. The mean of these measurements gave the "mean horizontal intensity."

Starting again from the first position, the lamp was rotated in the plane of the prime meridian and 13 measurements were made at equal intervals of 30 degrees, the last checking the first, and making four measurements of the point 0° latitude, 0° longitude. The mean of these four was called the "standard reading." If any noticeable discrepancy was noticed, the measurements at this point were repeated. As this point was that on which the calculations for the duration test were based, its careful determination was essential.

The lamp was then moved 45° horizontally, so that 0° latitude, 45° longitude E. was towards the photometer. It was then rotated in the vertical plane passing through that point and 13 measurements made as before, at intervals of 30 degrees, the last checking the first.

The lamp was next moved 45° horizontally, so that 0° latitude, and 90° longitude E. was towards the photometer, and 13 measurements made in that meridian as before.

Lastly, the lamp was rotated till 0° latitude, 135° longitude E. was towards the photometer and 12, 30 degree measurements made in that meridian, checking with a 13th.

This makes a total of 65 measurements on each lamp. As the sockets in use with all the lamps prevented the exit of any light from the bottom or south pole of the lamp, the reading at that point was always taken as zero.

The measurements were combined as follows:

The mean of four readings at the north pole of lamp...	1
Four measurements on each of the parallels of 60° N. and 60° S. on the prime meridian and 90° meridian circle	8
Eight measurements on each of the parallels of 30° N. and 30° S. at the intersection of the meridian circles of 0°, 45°, 90° and 135°	16
Twelve measurements, 30° apart, on the equator	12
One zero reading for south pole (base of lamp)	1
Making a total of	38

By laying down the points on a sphere it will be found that they are very nearly equidistant, being somewhat nearer at the equator than at the poles.

The average of the illuminating power at these 38 points is taken at the mean spherical intensity of illuminating power.

Figure 1 shows the location of the 38 points. It is a photograph of a Mueller lamp of nearly spherical shape, around which four rubber bands are stretched to show the four meridian circles, and one rubber band to represent the equator. The square black patches show the 38 points.

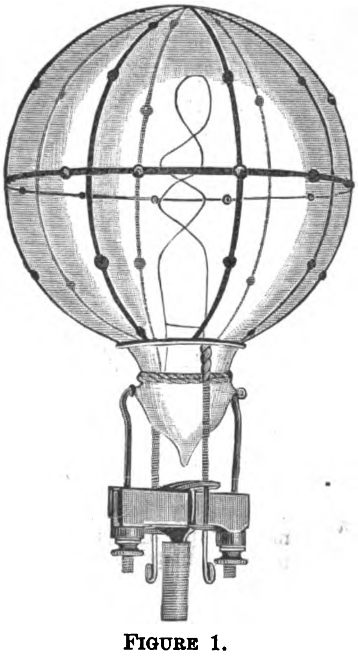


FIGURE 1.

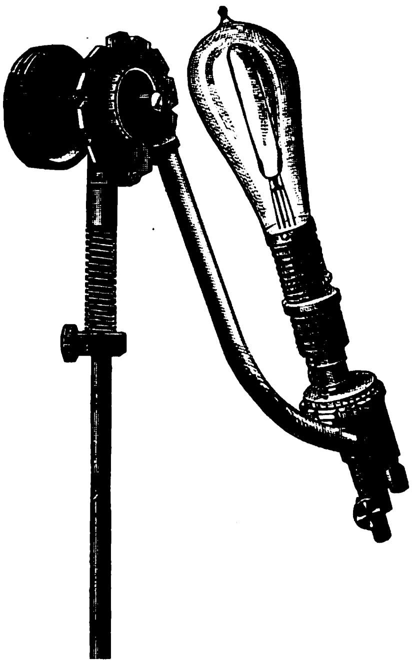
The particular lamp to be tested being placed in the lamp-holder, the potential was adjusted by means of the resistances in circuit with the lamp, and the candle power, current and potential determined. The current reached the lamp through wires dipping into mercury cups in the

piece of wood at the bottom of the lamp compartment. If a change occurred in the potential, photometric work was stopped until the potential was adjusted. Observations of current were taken about every four minutes.

The "reduction factor" used during the test for duration, was obtained by dividing the mean spherical intensity of illumination by the "standard reading" or the mean of the four observations at 0° lat., 0° long.

ELECTRICAL MEASUREMENTS.

The electrical measurements were made in a small room especially prepared for the purpose. The potential of the lamps was measured by a Wiedemann mirror galvanometer in a circuit of high resistance. The instrument employed was made by Hartmann, and was chosen on account of good damping. It had a Siemens bell magnet, suspended in a cylindrical cavity in a solid copper block. The mirror was attached to the suspending rod of the magnet. The fibre was about 15 centimetres in length, and was without appreciable torsion within the deflections used. The deflection of the magnet was observed by a telescope and scale at a distance of 176 centimetres, afterwards increased to 180. The galvanometer resistance was about two ohms, two coils, one on each side of the magnet being used in series; but a resistance of either 50,000 or 100,000 ohms was used in circuit with the instrument, the former being employed with lamps of less than 60 volts potential, the latter with others. The galvanometer was loaned to the committee by Prof. H. D. Todd, of the U. S. Naval Academy, and the reading telescope by Messrs. Jas. W. Queen & Co., of Philadelphia, who (through Mr. Walton, the head of the Philosophical Department) extended to the committee throughout the test, every convenience that their large stock of physical apparatus afforded.



Revolving Lamp Holder.

During the preliminary measurements for efficiency the potential was regulated by an observer at the telescope, who watched the deflection and recorded the potential at regular intervals, signaling any change to the photometer room, where the potential was adjusted by a change of resistance in the lamp circuit. In general this method worked well, but occasionally, through irregularity of the engine, the potential would fluctuate. Whenever the working conditions were bad, the results were rejected and the measurements repeated.

The lamp currents were measured by a tangent galvanometer, specially constructed for the test by Jas. W. Queen & Co. It consisted of a single coil of six turns No. 8 wire, on a brass frame of 60 cm. diameter. The base was of wood, two feet wide, resting on leveling screws. Both galvanometers stood on large wooden posts, buried two and a half feet in the earth, and out of contact with the floors or walls of the building. The needle and compass were loaned for the test by Mr. Weston. The circle was divided to 10′ and could be read by a magnifying glass to 1′ of arc. The maker's adjustments of the needle in the centre of the galvanometer coil were carefully verified.

The code prescribed the method by which the electrical units should be reproduced, and was strictly adhered to.

CURRENT.

The ampère was determined both by the silver voltameter and by calculations of the constant. During the test 38 calibrations were made of the tangent galvanometer by the silver voltameter. Eight of these were purely experimental, to determine the best conditions, and several of the others were rejected on account of bad conditions. All those were accepted in which the current was steady, the deposit good, and the time accurately determined. The current was supplied at first by a gravity battery, in multiple series, but later by a secondary battery.

RESISTANCE.

The ohm was by the code to be the Paris or legal ohm. In reproducing it, the committee had access to the standards and apparatus of the Johns Hopkins University, used by Prof. Rowland in his recent determination. The standard resistances of the test and the Wheatstone bridge used had their values carefully determined in Baltimore.

In the reductions the legal ohm was taken as 1.0112 B. A. units.

ELECTROMOTIVE FORCE.

The volt was determined by the fall of potential in a given resistance due to a known current. A reel of No. 22 german-silver wire was made by winding the wire on fine glass rods which were let at each end into pieces of black walnut. The turns of the wire were kept apart by turns of silk cord around the posts. The axis of the reel was surrounded by a stirrer, by which the excessive heating of the wire while in the bath was prevented. This reel was immersed in turpentine and later in refined petroleum (300° fire test, furnished by the courtesy of the Standard Oil Co.), and while in use in calibrations the liquid was kept in motion by the stirrer and the temperature regularly recorded. The ends of the wire were taken to double binding posts at the top of the reel, to which the current and potential leads were connected.

MEASUREMENTS OF EFFICIENCY.

The general method of making the observations for efficiency has already been stated. The committee aimed to test each lamp at its normal potential as stated by the makers, and to place it in the test for duration at the same potential, that the relation between efficiency and life might be traced. A few lamps were tested at two or more potentials. The efficiency measurements were begun at the earliest moment when it was thought that the arrangements for the test were sufficiently advanced to secure good results.

EFFICIENCY TESTS.

AVERAGE RESULTS.

Lamp.	Volts.	Ampères.	Watts	Candles. Mean Spherical.	Candles. Mean horizontal.	Watts per spher. cand.	Resistance. Cold.	Resistance. Hot.	Candles per Elec. H. P. Sphericel.	Candles per Elec. H. P. Horizontal.
Edison..............	97.57	.7065	68.92	15.47	19.24	4.459	247.5	...	169.2	210.4
Stanley, 96 volts....	96.56	.554	53.61	13.59	16.80	4.04	345.1	....	189.1	226.3
Stanley, 44 volts.. .	43.98	1.053	46.32	13.42	16.44	3.544	81.1	....	216.1	264.8
Woodhouse & Rawson, 55 volts (1st lot)	55.53	1.006	55.82	15.64	18.68	3.606	117.3	....	209.0	249.6
W. & R. (2d lot).....	55.00	1.178	64.77	18.30	22.13	3.56	100.2	....	210.8	254.9
White, 50 volts......	49.99	1.017	50.83	12.44	15.05	4.05	....	...	182.6	230.9
Weston, 110½ volts.	111.42	.530	59.04	16.43	18.07	3.718	407.9	....	209.8	240.7
Weston, 70 volts....	70.4	.968	68.09	15.18	16.85	4.51	150.	...	166.3	184.6

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DURATION TESTS.

EDISON LAMPS.

Lamp.	Hours of Test.	Life of Lamp.	Candles, Efficiency meas'rem'ts. Spher'l.	Horiz'l.	Candles. Spher.	Horiz.		Discoloration.
1	1,066	Survived.	15.3	18.8	9.3	11.4	After 1,006 h.	3
2	1,065	"	13.6	16.7	9.9	12.2	" "	2
3	"	"	14.2	17.2	9.7	11.7	" "	2
4	"	"	15.0	18.6	9.6	11.9	" "	2½
5	"	"	15.7	19.5	10.5	13.0	" "	2½
6	"	"	14.0	17.1	10.3	12.7	" "	2½
7	"	"	14.0	17.6	9.3	11.7	" "	2½
8	"	"	16.0	19.4	10.1	12.2	" "	3
9	"	"	14.4	17.7	9.7	11.9	" "	2½
10	"	"	14.0	17.7	9.8	12.4	" "	2
11	"	"	16.1	20.3	9.8	12.4	" "	3
12	"	"	13.1	16.7	10.3	13.1	" "	2
13	"	"	14.9	18.3	10.1	12.4	" "	2½
14	"	"	15.1	19.0	9.3	11.7	" "	3
15	"	295	15.1	19.0	12.4	15.6	" 260 h.	2
16	"	Survived.	15.5	19.6	9.3	11.7	" 1,006 h.	2½
17	"	"	16.0	20.3	8.9	11.3	" "	3
18	"	"	15.0	18.5	9.0	11.1	" "	2½
19	"	"	15.4	18.8	9.5	11.6	" "	2½
20	"	"	15.2	18.9	9.0	11.2	" "	2

STANLEY-THOMPSON LAMPS, 96 VOLTS.

Lamp.	Hours of Test.	Life of Lamp.	Candles in Efficiency tests. Spher'l.	Horiz'l.	Candles. Spher.	Horiz.		Discoloration.
26	1,065	78	12.8	15.4	12.3	14.7	After 53 h.	2
28	"	233	16.7	19.3	9.2	11.0	" 218 "	3
29	"	176	16.2	19.1	10.1	11.3	" 172 "	3½
30	"	Survived.	12.7	15.4	6.2	7.5	" 1,000 "	3
33	"	257	14.0	16.8	8.3	9.8	" 241 "	2
34	"	525	13.9	16.6	8.5	10.2	" 502 "	3½
35	"	100	13.2	16.2	10.4	12.7	" 100 "	2
36	"	301	16.3	19.4	8.4	10.0	" 241 "	3½
37	"	882	13.4	16.1	6.5	7.8	" 837 "	2½
41	"	683	11.9	14.3	7.9	9.5	" 670 "	2½

WESTON LAMPS, 110½ VOLTS.

Lamp.	Hours of Test.	Life of Lamp.	Candles in Efficiency tests. Spher'l.	Horiz'l.	Candles. Spher.	Horiz.		Discoloration.
1	1,065	227	16.6	18.4	10.8	11.9	After 198 h.	2½
2	"	47	13.8	14.9	....	....	....	½
3	"	Survived.	13.4	14.8	7.1	7.8	" 1,006 "	2
4	"	107	11.7	12.7	3.8	4.2	" 77 "	1½
5	"	320	15.0	16.4	10.4	11.4	" 289 "	2½
6	"	Survived.	10.4	11.2	10.0	10.8	" 1,006 "	2
7	"	"	17.3	19.0	2.9	3.2	" 1,006 "	2
8	"	141	19.2	21.4	10.0	11.1	" 141 "	2½
9	"	Survived.	15.6	17.0	6.5	7.1	" 1,006 "	2
10	"	823	18.2	19.7	10.0	10.9	" 789 "	2
11	"	169	15.4	17.0	2.8	3.1	" 148 "	1½
12	"	81	21.8	23.3	13.9	15.8	" 76 "	2
13	"	256	15.4	17.0	6.0	6.6	" 241 "	2
14	"	213	18.3	20.4	2.6	2.9	" 196 "	1
15	"	193	8.9	9.4	5.5	5.9	" 193 "	1
16	"	Survived.	14.2	15.4	9.1	10.0	" 1,006 "	3
17	"	41	11.3	13.1	....	...	....	½
18	"	Survived.	15.8	17.0	4.4	4.7	" 1,006 "	2
19	"	65	19 4	21.9	10.7	12.1	" 52 "	2
20	"	Survived.	18.5	19.9	9.5	10.2	" 1,006 "	2

WOODHOUSE & RAWSON LAMPS.

Lamp.	Hours of test.	Life of lamp.	Average potential.	Candles in efficiency tests. Spher'l	Horiz'l.	Candles. Spher'l.	Horiz'l.	After.	Discoloration.
1	1,065	41	....	18.5	21.5	....	....	....	3½
3	"	214	55.60	19.7	24.0	13.0	15.9	213 h.	4½
4	"	203	54.90	17.8	21.0	12.3	14.5	170 "	4½
5	"	440	54.55	13.3	15.6	10.4	12.2	289 "	4½
6	"	395	54.15	12.7	14.4	10.9	12.3	289 "	4
7	"	423	55.80	14.2	17.7	10.1	12.6	280 "	4½
8	"	118	55.75	13.6	16.5	12.8	15.5	78 "	3
9	"	716	55.00	17.0	20.4	6.6	7.8	716 "	5
10	"	69	55.20	10.8	12.7	12.4	14.6	32 "	2½
13 B	"	278	55.15	14.0	16.9	13.3	16.1	266 "	3½
30	332	Surv.	....	18.5	22.7	14.8	18.3	273 "	4
31	"	227	....	17.2	20.9	14.5	17.5	200 "	4
32	"	Surv.	....	17.4	21.3	13.9	17.1	272 "	3½
33	331	"	....	19.0	22.7	14.6	17.4	272 "	4
34	"	235	....	16.9	20.8	16.5	20.3	200 "	3
35	"	272	....	19.6	23.5	13.5	16.2	272 "	3½
36	"	Surv.	....	21.4	26.0	12.4	15.0	272 "	4
37	"	177	....	18.7	22.9	17.6	21.5	151 "	3½
[illegible]	"	224	....	17.9	20.8	17.0	19.7	200 "	4½
[illegible]	"	213	....	....	20.0*	15.3*	....	198 "	4

* Standard reading. No reduction factor.

WESTON LAMPS, 70 VOLTS.

Lamp.	Hours of test.	Life of lamp.	Candles in efficiency tests. Spher'l.	Horiz'l.	Candles. Spher'l.	Horiz'l.		Discoloration.
51	524	260	14.3	16.0	7.7	8.6	After 249 h.	2½
54	"	Survived.	14.0	15.2	13.1	14.4	" 465 "	2
55	"	"	16.7	18.3	14.8	16.3	" 465 "	2
56	"	"	14.7	16.4	13.9	15.7	" 465 "	2
58	"	"	16.3	17.9	13.3	14.6	" 465 "	2½
59	"	223	15.6	17.6	14.9	16.8	" 176 "	2½
61	"	Survived.	12.7	13.8	12.5	13.7	" 464 "	2
62	"	"	13.9	15.4	9.9	10.9	" 464 "	2
63	523	"	14.3	16.3	14.0	16.0	" 463 "	1½
64	"	463	14.8	16.1	14.0	15.4	" 462 "	2

STANLEY-THOMPSON LAMPS, 44 VOLTS.

Lamp.	Hours of test.	Life of lamp.	Average potent'l.	Candles in efficiency tests, Spher'l.	Horiz'l.	Candles. Spher.	Horiz'l.		Discoloration.
1	1,065	309	43.60	11.8	14.6	6.6	7.8	After 290 h.	4½
2	"	143	44.40	10.4	12.5	10.2	12.3	" 101 "	3½
3	"	137	46.85	16.0	19.7	8.0	9.8	" 101 "	4½
4	"	178	43.95	14.2	17.6	9.0	11.2	" 173 "	4½
6	"	288	43.85	10 4	17.1	6.8	8.3	" 280 "	3½
7	"	303	42.40	12.6	15.4	9.5	11.6	" 283 "	4
8	1,047	Surv.	43.65	10.8	13.2	5.4	6.6	" 987 "	4
9	1,065	40	.....	16.6	19.9	....	....	...	2½
10	"	206	43.20	16.3	19.7	10.0	12.1	" 202 "	3½
11	"	275	44.10	15.8	19.4	6.5	8.3	" 265 "	4½
12	865	307*	.....	11.0†	....	9.2	....	" 307 "	6

*Accidentally destroyed.
†Standard reading. No reduction factor.

WHITE LAMPS.

Lamp.	Hours of test.	Life of lamp.	Candles in efficiency tests. Spher'l.	Horiz'l.	Candles. Spher'l.	Horiz'l.		Discoloration.
1	312	Survived.	10.8	13.1	15.9	19.2	After.	3½
2	"	"	11.0	13.2	14.3	17.2	253 h.	2½
3	"	"	9.1	11.1	12.1	14.8	252 "	3
4	311	"	14.2	17.2	14.6	17.7	252 "	3
5	"	"	14.3	17.1	12.1	14.4	252 "	4
6	"	229	14.6	17.6	15.4	18.5	252 "	4
7	"	160	14.0	17.0	15.7	19.0	227 "	3½
8	"	Survived.	11.7	14.2	13.2	16.1	132 "	3
9	"	165	13.2	15.9	15.6	18.7	250 "	2½
10	310	Survived.	11.6	14.3	11.3	13.9	132 "	3
							250 "	

AN EXPLANATORY CORRESPONDENCE.

In submitting its report on the tests of the Weston 110½ volt lamps, the committee deemed it proper to insert the correspondence which had taken place with Mr. Weston, and Mr. Edison's representative.

The 110½ volt lamps were received from the United States company in January. Efficiency measurements were made on the 5th, 6th and 7th of February. On the 18th of February, Mr. Weston visited the exhibition building, was shown the results of the efficiency measurements on his lamps, examined into the installation, and the working methods of the test, and thinking the candle power of some of them low, addressed the following to the committee :

PHILADELPHIA, February 18, 1885.

Having examined the methods of testing used and the results obtained in the efficiency determinations, I would request a re-measurement of my lamps numbered 4, 6, 15 and 17.

I am satisfied that the methods used are such as will produce correct results.

EDWARD WESTON.

The lamps designated were re-tested and the accuracy of the former measurements verified. On the 7th of March the preliminary run for working methods began. Owing to irregular working of the engine, causing flickering in the lamps, it was prolonged a week, that better working might be secured. On March 17th the committee had arranged to begin the duration test at 2 P. M. Very shortly before that time, the representative of the United States company, who had not been in attendance on the

tests for several weeks, although his presence had frequently been solicited, arrived with the following letter from Mr. Weston:

LABORATORY OF EDWARD WESTON, 107 ORANGE STREET, NEWARK, N. J., March 16, 1885.

Prof. WM. D. MARKS.

DEAR SIR:—The very marked difference in candle power of our lamps, as shown in the tabulated results of the tests made in Philadelphia, surprised me very much, particularly as our lamps are remarkably uniform in this respect, and must necessarily be so when properly made, owing to the peculiar method of treating the loops.

After arriving here I commenced to investigate the matter, and soon found that you had been supplied with a singularly bad lot of lamps; the defect being due to imperfect baking of the loops. This has been so imperfectly done that you will find it impossible to maintain the candle power uniform for even a very short period of time without increasing the E. M. F. The resistance of the loops will rise rapidly, and the lamps will rapidly deteriorate and fail in such a short time as to leave no doubt in your mind that if we made such lamps regularly we could not possibly continue to do business. In other words, the lamps are thoroughly worthless.

In view of these facts, I think it is useless to spend any time on the lamps of our make which you now have, and since there is no provision in the code for such a contingency as has arisen, I respectfully submit this statement of facts to the committee, and ask for a careful consideration of the matter.

Deeply regretting that anything should have occurred on our part to still further prolong and increase the cost of a series of tests which must necessarily be very tedious and expensive, I remain, Yours respectfully, EDWARD WESTON.

The members of the committee present agreed with Mr. Weston that the code provided no remedy for a case of this kind, and agreed to postpone the beginning of the test and to refer the matter to the Edison company, that the competing parties might enter upon new arrangements. The Edison company, through Mr. Upton, agreed that Mr. Weston should have the privilege of entering another lot of lamps of the same general character and grade as those already tested, and the committee, desirous of obtaining good lamps for test, agreed to measure them when received. On the 1st of April a conference took place between Messrs. Weston and Upton, the president of the Franklin Institute and a portion of the committee, at which Mr. Weston stated he thought there would be no doubt but that the new lot of lamps would be on hand within a week.

The allotted time having expired without anything being received from him, Prof. Marks notified Mr. Weston that the engagements of some of the members of the committee compelled the fixing of April 11th as the date beyond which further postponement was impossible.

On April 9th another conference was held, at which the representative of the Edison company objected to Mr. Weston withdrawing his lamps, and addressed the following letter to the committee:

Prof. WM. D. MARKS, *Chairman.*

DEAR SIR:—The Edison company desire that the test of lamps be proceeded with under the code without further delay.

Respectfully,
FRANCIS R. UPTON.

65 Fifth avenue, April 9th, 1885.

This request that the test should be continued under the code, the failure of Mr. Weston to provide new lamps, together with the impossibility of further delay if the test was to take place at all, gave the committee no option but to proceed under the code with the lamps on hand. In order to prevent any misunderstanding on the part of Mr. Weston, he was notified by letter and telegram that the test would begin on the 11th. A few hours after the beginning of the test, the following telegram was received:

Prof. WM. D. MARKS.

Your telegram surprised me. The lamps have been withdrawn. Our position in this respect is fully caused by your letter of April 8th. I presumed that this was the final judgment of the committee pending a reply from me. There is no clause in the code by which the Edison company can compel the committee to proceed as indicated in your telegram; neither the committee nor the Edison company have any right to re-enter our lamps without our consent. My letter in reply to yours of the 8th will fully cover these points. EDWARD WESTON.

The matter was immediately considered by the full committee, and answered as follows:

PHILADELPHIA, April 11, 1885.

EDWARD WESTON,
Newark, New Jersey.

In reply to your telegram of to-day, the committee have considered the question you raise. It was understood by them that the verbal conference of Thursday evening, at which you were present, made it clear that the formal demand of one of the competitors that the test should proceed left the members of the committee then present no option in the matter, and rendered the letter of the 8th nugatory. Under the provisions of the code any questions between the contestants and the committee can be settled by a unanimous vote of the committee, and the undersigned give their decision that under the code no withdrawal is possible, and their letter of the 8th becomes invalid when questioned by a contestant.

J. B. MURDOCK, G. M. WARD,
L. DUNCAN, WM. D. MARKS.

Subsequently another letter was received from Mr. Weston and another conference held at his request, but the committee regarded their action as final and nothing was done.

The committee present the above as a matter of justice to Mr. Weston, and also as an explanation of their own course of action.

ATMOSPHERIC ELECTRICITY.

BY P. H. VAN DER WEYDE, M. D.

(President of the N. Y. Electrical Society.)

IN the August number of the ELECTRICIAN AND ELECTRICAL ENGINEER, Prof. Blake publishes a reply to my remarks upon his paper under the above heading, which reply requires a notice from my side. It was at the request of several members of the New York Electrical Society (before which, in the absence of its author, the paper was read by Dr. Keith) that my remarks were published at the same time. For this purpose I wrote them down, shortly after the meeting. While doing this, I found that I could have said a great deal more to elucidate the theory which I have been teaching since 1840, and to which the later labors of Riess, Wiedeman, Piazzi, Thomson and others, have only added details and corrections, without upsetting its fundamental principle, which is also accepted by Professor Blake, namely, the theory first announced by Peltier, 50 years ago,[1] and soon adopted by Quetelet, of Brussels, and Lamont, of Munich, that *the earth's surface possesses naturally a negative charge of electricity.* As, however, my remarks appeared to occupy almost as much space as the paper to which they were appended, I refrained from adding anything more. I am glad that Prof. Blake's reply gives me an opportunity to fill up omissions incident to extempore speaking.

When, under the comprehensive title of "Atmospheric Electricity," a writer begins with mentioning opinions of the Greeks and Romans in regard to the nature of thunder storms, and refers to experiments of Franklin, Becquerel, De la Rive, and others, one would naturally expect that some attempt would be made to show in how far the theory which the writer adopts will explain the source of atmospheric electricity. No wonder that a feeling of disappointment was produced when I became aware that the contents of the paper were confined to the account of a few experiments by which the writer failed to transmit electricity, either by convection or by conduction, what others claim to have accomplished. As in years gone by I had also made experiments of the same kind, studied the causes of frequent failures, and believed to have found them, I could not refrain from speaking; and after seeing that no member of the society offered any remarks, I gave an account of the convictions I had arrived

1. Garnier: Meteorologie. Brussels, 1837; p. 221.

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at more than 20 years ago, namely, *the influence of the dew point*, the importance of which upon the subject under discussion Prof. Blake, to my regret, "fails to grasp;" at least, in his reply he does not make the slightest allusion to it. Perhaps he considers it an insignificant suggestion, but I think it worthy of serious consideration, as it is one of the causes of the discrepancies in the results of various experiments. I hope presently to show that most likely it is *this*, and not the greater delicacy of modern appliances, which is at the bottom of the question.

If the title and introduction of the paper had conformed with its contents, I would certainly not have charged the writer with onesidedness, but as he starts with the theory of Peltier, referred to, I expected, in connection with the title, a less onesided consideration of this beautiful proposition, so fruitful in the deductions which may be drawn from it. The suggestion which he makes, that I perhaps expected that the paper would "discuss all the theories as to the cause of atmospheric electricity advanced in times past and present," is simply absurd, because there are few subjects on which so much has been written; in fact, not to speak of what may be found in text books and cyclopedias, the number of separate papers on the subject in English, French, German, Italian and Dutch, is truly appalling, and constitute a library by themselves; while the diversity of assumptions and opinions is so great that physicists are in this respect on an equal footing with theologians and lawyers, being also able to prove their favorite notions, whatever they may be, by quotations from supposed authorities, who, as I hope to show, are not infallible. As an instance, I will here merely make the preliminary remark, that most of them overlook the fact that the terrestrial surface is very rough, and not at all like a smooth brass plate, "heated by a flame from below;" therefore, experiments made in this way prove nothing in regard to the operations of nature. Any one in the least acquainted with the literature of the subject, knows that Pouillet was mistaken in the deductions he made from his experiments, but this does not prove that, for instance, Matteucii was mistaken when this eminent Italian physicist found that if using moist earth and sunshine, in place of brass plates and flames, electricity was developed by evaporation.[2] It is not enough to use delicate and elaborate modern appliances; they do not make up for sound judgment and circumspection in regard to the other complicated circumstances under which nature operates.

In the second paragraph of his reply, Prof. Blake asserts that "*quiet evaporation* is the only kind of evaporation occurring in nature." This assertion simply astonishes me. Does he call the evaporation of a storm-tossed ocean a "quiet evaporation"? Does he consider as such the forced evaporation from the millions of leaves of the trees, when a hurricane sweeps through the forests? If evaporation is not here the cause of electric development, may it not be the friction of the air on the surface of the water, or on the leaves, as has been proved by Reich[3] and Riess,[4] that in the Pouillet experiment with the hot crucible and water in the spheroidal condition, it was friction, and not evaporation, which generated the electricity developed. This, therefore, may be another source of electricity, which, however, it would be difficult, if not impossible, to verify by experiment on a small scale.

Any one who, during a hurricane, has been in mid-ocean and observed how the tops of the waves are curled over by the wind, must have become convinced that there is considerable friction between air and water; the existence of this friction is evident even when a gentle breeze ripples the surface of a quiet lake, and further demonstrated by the well-known fact, that it may be corrected in the same way that we correct the friction between solids, namely, by a lubricator; hence the quieting influence of oil poured upon the surface of water agitated by the wind.

Query: Does perhaps the gaseous envelop surrounding our partly liquid and partly solid globe, almost continually moving and rubbing the terrestial surface, constitute a gigantic friction machine?

I do by no means consider induction as the only source of atmospheric electricity, as Prof. Blake appears to infer from my remarks. Previous to my explanation of induction, I spoke of conduction, in case a cloud or mist is in contact with the earth, and afterward I mentioned induction as a most prolific source of atmospheric electricity, by no means asserting that this would explain all; to the contrary, I said at the beginning of my remarks that I "admitted that the existing theories upon the origin of atmospheric electricity are not fully satisfactory to explain *all* the details of the phenomena exhibited." But I meant to say that I consider the theory of Peltier as the most satisfactory, and that when rightly understood and applied, it will explain many phenomena about which a number of investigators are still in doubt, and appear to have agreed to disagree.

But the main point upon which the professor's defense appears to rest, is that in my extempore remarks I happened not to speak of "convection," but only of "conduction." He infers from this that there is in my mind "a confusion of the scientific distinction between them," and, further on, he says that I "entirely failed to grasp the difference between convection and conduction." I answer, that he entirely fails to grasp the relation existing between them, which is so intimate that most of what I have said of conductibility may be said of convection also, and Prof. Blake commits a grievous error when he says that my remarks about "the conductibility of watery vapor have no bearing at all upon the subject." I claim that *in order to make convection possible, the substance which is to convect the electric charge must have the capacity to hold electricity;* and I claim also, that the air heated in the way described by Prof. Blake, and as reported by Helmholtz to the Royal Academy, notwithstanding it was charged with some watery vapor, is so poor a conductor as to make it unfit to acquire a charge of electricity; consequently it could not convect it. Even their own experiments, as described, prove this, because if it had been a conductor (what I tried to explain it could not be), the moisture between the two brass plates would have communicated the electricity to the upper plate, and *it would have become electrified by conduction, if not by convection. The result of the experiment would have been all the same.*

I should like to be informed by Prof. Blake, how, in case his experiments with the brass plates had succeeded, he would have demonstrated that it was by *convection* alone and not by *conduction* that the upper plate became charged.

It may be well to quote some authorities here, in order to settle the matter about the resistance of air against electrification. It is a principle at present agreed upon that *pure air has no electricity whatsoever and is incapable of conducting or retaining it*;[5] consequently it cannot convect it. Or stated in connection with Peltier's theory, it has been said that: "*dry air is not electrical by itself, the earth has a resinous tension, and the* (upper highly rarefied) *space a vitreous tension*."[6] Therefore, the condensed air along the earth's surface forms a neutral insulating layer, separating the electricity below from that above. Sir William Thomson compares it to a huge Leyden jar, of which the earth's conducting surface is the interior lining, the condensed air the dielectric, and the conducting upper rarified stratum of air the outer coating, while the interior of the jar is charged with negative electricity, of which the positive charge of the upper stratum is the electropolar complement.[7]

2. Daguin: Traité de Physique. Paris, 1856. Vol. ii., pp. 499 and 500.
3. Abhand. Kon. Sach. Gesel. Leipsic, 1846; p. 199.
4. Pogg. Annalen. Lxix.; p. 286.
5. Mueller: Kosmischen Physik. Braunschweig, 1872; p. 697.
6. Annual Report of Smithsonian Institution. 1870; p. 195.
7. Noad: Student's Text Book of Electricity. London, 1879; p. 114.

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I feel inclined to interpolate here the remark that if it were not for this insulating property of the condensed air we live in, mankind would forever have remained in ignorance of anything relating to static electricity (and, consequently, dynamic electricity also), because we would be unable to retain the static charges—they would diffuse themselves as soon as developed. It follows from this that when in winter our experiments with this kind of electricity are very successful, we are wrong in saying that there is much electricity in the air; it is exactly the reverse, because when the air is incapable of becoming charged the insulation of our apparatus is more perfect. In summer, when evaporation is active and the air moist, the insulation becomes defective because the air becomes slightly charged, and experiments depending upon insulation are not satisfactory.

We know that ordinary air, even on a so-called dry day, contains some moisture, and that absolutely dry air exists only temporarily in some exceptional localities, still we know that the ordinary dry air notwithstanding it contains some moisture, is by no means a good conductor, but belongs rather to the insulating substances, and what I attempted to point out in my remarks was, that moist air, heated above the dew point, is practically equivalent to dry air, and will neither transmit electricity by conduction nor by convection, and I repeat with a slight modification what I said in my remarks, namely: *if we wish to evolve a vapor which will convect electricity, the temperature should not be too high, the air of the room moist, and the barometer low.* This is the case in nature when a mist becomes negatively electrified by contact with the earth's surface; and I stated distinctly that in such a case the negative charge will accumulate *on the upper surface* of the mist. If its conductive contact with the earth becomes imperfect while its upper portions retain their full capacity of conductivity, by reason of lower temperature and lesser atmospheric pressure, the lower portions of the mist must show traces of positive electricity, generated by induction from the negative terrestial surface, like the lower surface of clouds, must have a tendency to show positive or less negative electricity, while the upper portions are strongly negative. Prof. Blake in his reply misapprehends my meaning because he has confused the upper and lower portions of the mist, when he says that, according to my remarks, "this conducting mass (the mist) should be negative, while it has always been found to be positive." I remind him that in order to find the negative charge the observer will have to ascend as high as the conductivity of the mist extends,[8] while on the earth's surface no electricity will be perceptible. These are my words, and I add now that seldom or never a negative charge will be found in the lower portions of a mist, but either no charge at all according to the law of conducting spheres, as I have stated in my remarks, or a positive charge, in case the conductivity of the lower surface layers is impaired.

If such a mist ascends, and mingles with the clouds above we have pure convection on a large scale. In order now to establish convection on a small scale we must secure the conditions upon which, in my remarks, I have laid so much stress, and of which I hoped that the importance would be comprehended and not passed over in silence. I must therefore state them again; they are: *the capacity of watery vapor to conduct and convect electricity depends upon its condition in regard to the dew point; when temperature and atmospheric pressure are below the dew point the misty vapor can hold, conduct and convect electric charges, witness the clouds; but when temperature and pressure are above the dew point, the mistiness disappears, the air becomes clear and comparatively dry, it will almost entirely lose its electrical capacity, and it will neither hold, conduct nor convect.*

The latter conditions were those under which Prof. Blake's and Helmholtz's experiments were made, and they illustrate forcibly the results of conditions, under which we cannot expect either conduction or convection. In order to be complete, the experiments should also be made under the conditions which I have mentioned, and which are those which frequently prevail in nature when the electricity of the earth's surface ascends by conduction and by convection, which undoubtedly often restore the electrical equilibrium downward as well as upward, both unperceived, and only ascertainable by special appliances, which the older investigators possessed as well as the later ones. It is true the appliances were not as refined, but it should not be lost sight of that, for instance, the operation of an old fashioned gold leaf electroscope is as sure an indication of the existence of electricity as is that of Helmholtz's quadrant electrometer, and that an old fashioned frictional machine as used 25 years ago in my experiments in this line, produces electricity as well as a zinc-water-copper battery. When properly managed it gives a kind of electricity much more similar to that of the atmosphere than is produced by the latter, which I do not consider so well adapted for the purpose, and would not use in this case notwithstanding I possess three of them of 2,560 elements each.

De la Rive mentions a fact showing the difference between this kind of electricity and that of the atmosphere. He states that a delicate galvanometer with 2,400 windings, carefully insulated, and which therefore would give very decided indications with the 500 elements of the zinc-water-copper battery, used by Prof. Blake, did not enable him to perceive sufficient atmospheric electricity so as to recognize daily or yearly periodicities. It was only at the approach of thunder clouds, with rain and snow, that decided indications were perceived.[9] When we consider that the old style electroscope, as used for static electricity, in connection with proper condensers, gives very decided indications about daily variations in the electrical conditions of the atmosphere, the greater similarity of the latter with ordinary static electricity becomes evident.

I cannot omit here, expressing my regret that there is at present a tendency to treat older experiments as worthless, because they were performed with less pretentious instruments than exist at the present day. I wish that the average physicists would follow the example of the average microscopist, who, armed with the magnificent immersion lenses and other appliances of the present day, still give due praise and credit to the pioneers in their branch of science, such as Leeuwenhoek, Lieberkuehn, Lyonet, Ellis, etc., for what they have accomplished by their less perfect instruments.

My first experience in atmospheric electricity dates as far back as 1829, when I assisted General Kraaijenhoff[10] in his investigations upon this important subject. Through an opening in the roof of his palatial residence, he had a very long insulated lightning rod erected, which could at will be connected to the ground, or with the proper electrical apparatus known at that time, and with which the attic story was well provided, while the whole arrangement left nothing to be desired in regard to peculiar convenience and perfect safety. I frequently amused myself there with boyish delight repeating with atmospheric electricity the experiments then known and usually made with frictional electricity. In the meantime I became powerfully impressed by the sight of the enormous quantities often

8. Mueller: Kosmischen Physik; p. 698.

9. De la Rive: Traité d'Electricité. Paris, 1858. Vol. iii.; p. 110, foot note.

10. This eminent Dutch engineer and physicist, who had during his active life occupied various exalted positions, such as inspector of fortifications under the first Napoleon, and as minister of war under his brother, Louis Bonaparte (once King of Holland and the father of the late Napoleon III.), devoted the latter years of his eventful life quietly to the advancement of physical sciences, especially in regard to the then already rapidly extending branch of electricity. The French royal academy awarded to him the first prize for his extensive essay on the advantages incident to the study of electrical science. This work, first written in Latin, was afterward translated into French and Italian. In his younger years he wrote a book entitled "Electrical Physics," and later (1886) published a treatise with instructions on the proper construction of lightning rods, he having been the first to erect effective and reliable lightning rods in different parts of the western portion of the European continent. In 1782 he directed the placing of a lightning rod upon the great church spire of Doesburg, Netherland, which tower before that time had every year been struck by lightning and damaged, but which afterward was found to be perfectly proof against such calamities.

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discharged and beyond our capacity of computation, and still more the occasional high intensity of discharges equivalent to millions of volts, all of which are only weakly approached by our most powerful modern arc-light dynamos. It also impressed me in early life with the conviction that it is very risky to deduce positive opinions about the gigantic operations going on in the atmosphere, from the experiments we make with our static machines, which are comparatively mere toys. Still I admit, of course, that those experiments have initiated man into one of the most important secret agencies of nature, and solved problems which have been mysteries to our ancestors, and are still so to the ignorant.

During more than 50 years that I have been lecturing on physics, I have of course taught the phenomena attending the propagation of electricity by convection and by conduction, and during the last 20 years have laid particular stress upon the fact that convection and conduction through air is facilitated, by bringing temperature and pressure below the dew point, as explained above, and I have occasionally illustrated this by placing moistened earth under the bell-jar of an air pump, and exhausting slightly until the well-known fogginess appeared, always seen at the beginning of exhaustion, when sufficient moisture is present in the bell-jar. It is then found that the electricity is conveyed (both by conduction and convection) to the upper plate, which it is better not to have smoothly polished but rough; better still is a wet sponge as it is more similar to a cloud, and will contribute its share to make the air sufficiently moist so as to better enable it to conduct and convect. If the experiment is made with dry earth and dry air it is necessary to exhaust considerably and substitute a ground connection for the electroscope; then the familiar luminous phenomena will be seen, known as the aurora tube experiments, similar to the Geissler tubes, etc. In this case the electricity is visible in the dark; in the former case, when passing through air oversaturated with moisture, it is invisible but manifests itself on the electroscope connected with the upper plate or wet sponge.

Another point of which I have not spoken yet, and which I never omitted to instruct my class in, was this: like *conduction* of the air is aided by saturating it with moisture and keeping it cool, so *convection* through air is facilitated by projections, especially by points, so that air which otherwise would not convect electricity, can be forced to do so by a proper form of the electrically charged conductors. Various lecture room experiments illustrate this, and nature does it in the St. Elms fire, in pointed lightning rods, often also with the tops of the masts of ships, and occasionally with the tops of trees, and even with the ears of horses and the raised hands of men. [11] Dryness of the air is a condition for these phenomena, as proved by the fact observed, that wetting some of the objects causes the light emanating from them to disappear; it does not, of course, stop the electric discharge, but the watery vapor makes it invisible.

If now we do not take advantage of this property of projecting points and do not use something equivalent, in case we wish to convect electricity, but instead of this, use smooth brass plates, we commit an oversight of nature's methods in the experiments under discussion.

The resistance offered to convection by flat circular surfaces is forcibly illustrated in the electrophorus, in which the charged lower surface holds its negative electricity, notwithstanding the absolute contact of the metallic cover, out of which, by the ordinary operation of this instructive apparatus, a great number of positive charges may be obtained *by induction*, far surpassing in their totality the original negative charge, and this without diminishing the latter.

This leads me to the last point in the reply, which I have to notice. I have stated a theory (which is not mine exclusively), that the earth may charge clouds by induction, and that these may charge one another, and are known even to charge locally the terrestrial surface by induction. [12] Prof. Blake attempts to dispose of this theory by mentioning the observations with Sir W. Thomson's water-dropping collector, which indicates a low potential of the earth's charge, and winds up the paragraph by saying: "The atmospheric electrification, which, according to the remarks, is the *induced* charge, must enormously surpass the earth's charge, or the induced exceed the inducing electrification, which is absurd."

This is a very thoughtless expression. Old as well as modern experiments abound with illustrations that the potential of weak charges may be enormously intensified in various ways; also those obtained by induction may be again intensified by induction. The condenser of Volta is based on this principle, as is also the duplicator of Bennet improved by Cavallo, which was known more than a century ago; while with the improved multiplicator of Nicholson [13] the merest trace of an electric charge can be increased enormously by inductive action.

Such and similar apparatus was a century ago successfully used for the determination of the electric charges of rain, snow, hail, etc. [14]

The Holtz machine and its modifications (which may be considered as improvements upon the old-fashioned revolving multiplicators of 100 years ago) show how, by the aid of inductive action and air friction, the original slight static charge (made by a small piece of vulcanite rubbed by a proper material) may be increased enormously; while the Ruhmkorf coil is an illustration of how a weak dynamic current of a few insignificant elements may be raised to a very high potential, surpassing that of the original, thousands of times.

Biot gives formulæ by which he proves the enormous increase of potential toward the extremities when a charged conductor is elongated. [15] If we apply this to a weakly charged cloud, and suppose it to be stretched out by winds or by the attraction of clouds charged with an opposite electricity, we find here another possible source of increase of the potential.

The total disregard of the many ways by which weak charges of clouds may be increased to a high potential is so much more surprising from the side of Prof. Blake, because at the end of his reply he mentions the theory of Taite in regard to "the increase of potential by the agglomeration of the vapor particles into drops, so as to form clouds and rain, according to the law of the dependence of the potential of a sphere upon its radius," and he says that it would "be plausible if we can only account for the original electrification of the minute vapor particles in the air." According to what I have explained, he has only to make these vapor particles vesicular, that means, reduce them to the state of mist, either by cold or diminished atmospheric pressure, or both; then they will hold, conduct and convect the terrestrial charge upward.

I find, just now, that Du Moncel expresses a similar opinion when he says that "water diffused in the air in the vesicular state (the state of mist), is a secondary conductor, which means a character of inferior conductivity, which, however, permits that when placed between two charges of opposite electricities, the discharge will take place at much greater distances than through ordinary air." [16]

As soon as I became convinced of the correctness of the theory stated by Mueller and referred to above, *that clear transparent air cannot hold electricity*, it became evident to my mind that the potential of a cloud can be enor-

11. Marbach: Physikalisches Lexicon. Leipsig, 1836. Vol. iii., p. 489.

12. Biot: Traité de Physique. Paris, 1816. Vol. ii., pp. 452 and 453.
Pouillet: Elements de Physique et Meteorology. Brussels, 1840; p. 447.
13. Phil. Trans. 1788. Vol. lxxviii., p. 11.
14. Phil. Trans. 1788. Vol. lxxviii., p. 403.
Lehre von der Electricitaet. Erfurt. 1784. Vol. ii., p. 491.
Ephemrides Societ. Meteor. Palat. Vol. i., p. 85.
Rosier: Observ. et Memoires sur la Physique. Vol. iii. Jan., 1774.
15. Biot: Traité de Physique. Vol. ii., p. 445.
16. De la Rive: Traité d'Electricity. Vol. iii., p. 181.

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mously increased when it becomes smaller by the dissolution of the parts constituting its exterior boundaries, into clear air. If such air cannot hold electricity, every dissolving particle must convey its charge to the neighboring one which remains in the state of mist or cloud, and this process will go on in the apparently contracting cloud until the potential of the charge becomes so strong as to be able to leap over the distance separating it from the nearest conductor, when we will have a stroke of lightning. This explains also the thunder and lightning explosions occasionally observed from an apparently clear sky; they result from a disappearing charged cloud.

It was in 1873 that I first read in the third edition of Mueller's "Kosmischen Physik," published in 1872, this principle about the incapacity of air for electric charges, and applying to it the results of my experiments, referred to above, and which I had made in 1861–1862, while occupying the chair of Physics in the Cooper Union, New York, I conceived the theory just mentioned, while in 1880 I found that it was very similar to that of Taite, published in *Nature* for September of that year; only what I conceived to be the case in the limit of a cloud, Taite beautifully considers in every individual vapor particle when it becomes a minute rain drop; but Taite did not start from the fact that the air has no capacity for electric charges, which lies at the basis of my theory about the cause—how the potential of a cloud may be raised as a whole.

There is a well-known little lecture-room experiment, which I always exhibit in this connection. It consists of employing an insulated cylinder upon which a piece of conducting cloth can be wound and unwound; an electroscope attached to the same shows a remarkable increase of potential, when, after charging the cloth, the surface is decreased by winding it upon the roller, and *vice versa.*[17] The piece of cloth represents here the cloud of which the potential is raised by decrease of surface.

While writing the above a great deal more comes to my mind, which I should like to add, were this article not already becoming too long; but as the subject is so enormous in extent, physically as well as mentally, and as it has seriously occupied my mind, off and on, for nearly 60 years, I may return to it in some following number. It is perhaps well that the stimulus of self-defense against Prof. Blake's attack has induced me to take more trouble than I otherwise would have taken in bringing some of the results of my long and quiet labors before the readers of the Electrician and Electrical Engineer.

Brooklyn, April 20, 1885.

17. Noad: Stud. Text Book. London, 1879; p. 17.
Ganot: Elem. Physics. London, 1872; p. 537.
Mueller Pouillet: Physik. Leipzig, 1881. Vol. iii., p. 183.

THE MAMMOTH TANGENT GALVANOMETER AT CORNELL.

BY W. A. ANTHONY, PH.B.

The tangent galvanometer described in this paper was constructed to serve as a standard instrument for the measurement of currents of all magnitudes, from one milliampère to 250 ampères. The writer had long felt the need of such an instrument in connection with investigations in progress in his laboratory, and for the purposes of experiment and instruction in the course in electrical engineering, as well as for standardizing the commercial instruments used for measuring electric lighting currents.

Plans and drawings were in progress when the writer was invited to take part in the dynamo tests at Philadelphia. In the progress of that work many valuable hints were obtained as to the requirements which such an instrument should meet, and in subsequently completing the plans the endeavor was to meet all the requirements and fulfill all the conditions that experience had shown to be important.

The most essential conditions were: that the dimensions should be such that they could be obtained with great precision, and at the same time make it unnecessary to consider the small corrections due to the length of the needle; that it should be possible to read the deflections upon a *graduated circle* to fractions of a minute; that the coils should be of such dimensions and capable of such combinations as to give a variety of constants; that the needle should be as nearly as possible "dead beat," and that the instrument should contain within itself the means of obtaining the horizontal intensity of the earth's magnetism.

For the measurement of heavy currents it was necessary that the coils should be of wire sufficiently large to avoid heating and consequent alteration of their dimensions.

The plan upon which the instrument was finally constructed is that of Helmholtz. There are three pairs of equal coils—the coils of each pair being at a distance apart equal to their radii, and symmetrically placed with reference to a central point where the needle is located.

The coils for heavy currents are four in number, each a single turn of copper rod, 1.9 cm. in diameter. The diameter of one pair of coils is 200, and of the other 160 centimetres. (The dimensions given in this paper are those aimed at in the construction of the instrument. The actual dimensions have of course been carefully determined.) The constants of these coils are roughly: for the four in series, 8; for the two larger, 19; for one larger, 38; for the two larger, used differentially with the two smaller, 75; and for one large and one small coil used differentially, 150 ampères. Hence currents of from 4 to 250 ampères can be measured by deflections of the needle between 25 and 60 degrees.

These coils are mounted on a frame of cast brass accurately turned and adjusted. The currents are led to and from the coils by means of a rod surrounded by a tube of copper carefully insulated from it, and extending to a distance of about three metres from the coils. There the conducting wires are connected. These consist of copper wire, 1.17 cm. diameter, insulated with a thick covering of braided cotton saturated with paraffine, and the wires of each pair are twisted together. For smaller currents two coils, about 150 cm. diameter, of two wires, 2 mm. diameter each, were wound in grooves in the frame; both wires being wound at the same time, so as to occupy as nearly as possible the same position relative to the needle. When coupled in series, they form a coil of 36 turns, in six layers of six turns each. The two wires of the same coil, used differentially, produce only a barely sensible effect on the needle where one alone would cause a deflection of 50°. The object of this construction was to have the means of testing the accuracy of the adjustments of the galvanometer.

When the needle was adjusted to the middle point of the line joining the centres of the coils, no deflection was produced on reversing the current in the fine wire coils of each side used differentially; when if the needle was moved half a millimetre toward either side, such a reversal would produce a deflection of 10 minutes.

The same is true of the two smaller coils of copper rod. The two larger coils, however, gave a deflection, with the same current used on the smaller coils, of 9 minutes, owing to the fact that these two coils were not of exactly the same dimensions. The constants of these two coils, computed from the measured dimensions, are 37.828 and 37.818, a difference of a little more than one four-thousandth. This test of the accuracy of the adjustment of the instrument is, therefore, a very delicate one.

The needle consists of several pieces of fine steel wire cemented parallel to each other on a thin circular disc of aluminum, and cut to such lengths that their poles are very nearly in the circumference of a circle three centimetres in diameter. This construction was adopted to produce a powerful system whose poles could not be displaced by the action of a transverse field, which is a serious

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source of error in needles of considerable bulk, especially in the "bell-form" magnets of the German instruments. The circular form also tends to eliminate any error due to the dimensions of the needle. The needle is placed in a cavity in a copper block, which renders it very nearly "dead beat." It is suspended by a fibre of silk, with adjustments for centreing.

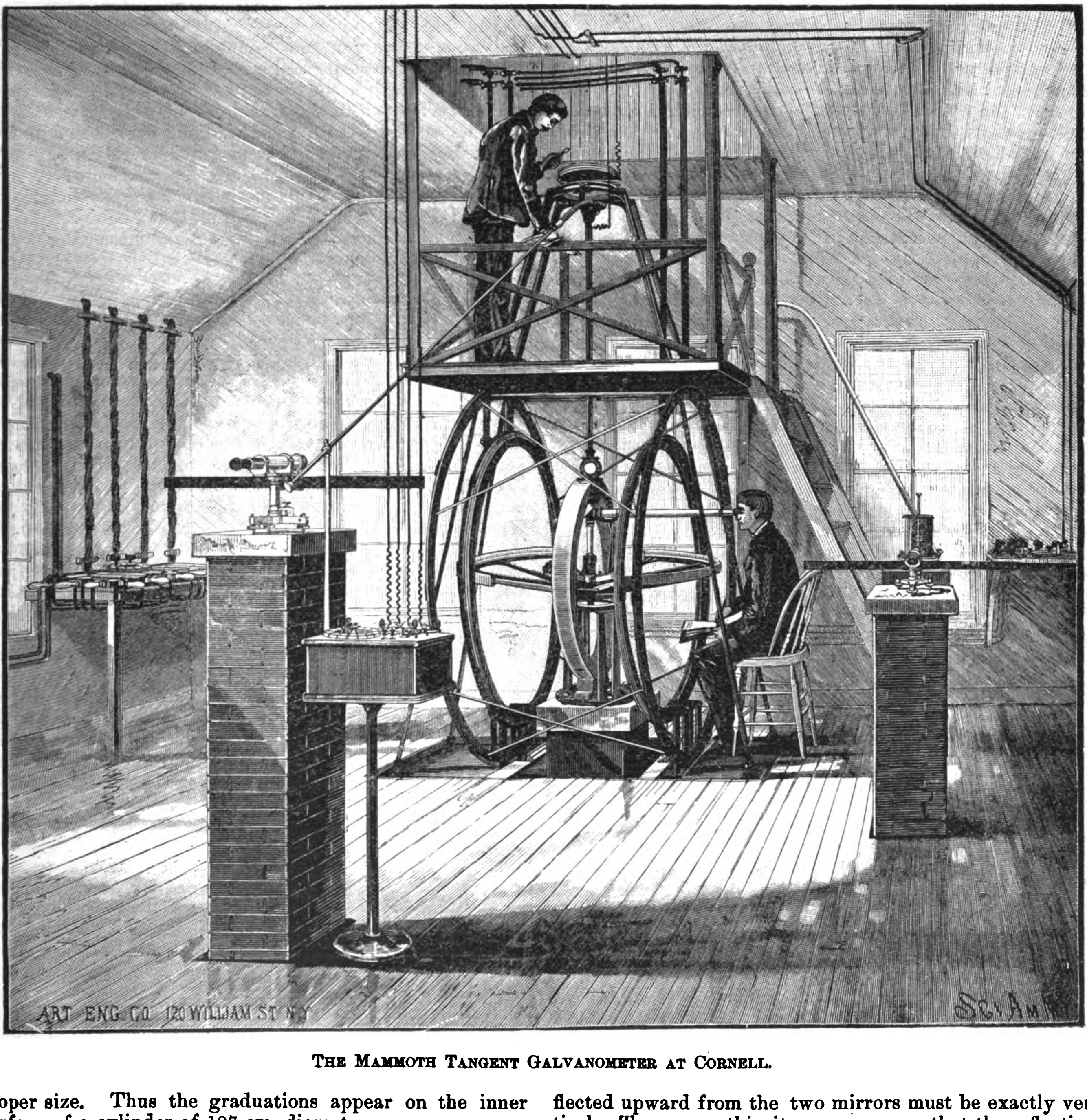
The divided circle on which the deflections are read was made by graduating thin brass strips and springing them into the inside of a cast brass rim accurately turned to the proper size. Thus the graduations appear on the inner surface of a cylinder of 127 cm. diameter.

For reading the deflections of the needle, two mirrors are rigidly connected with it at angles of 45° with the vertical, and so placed that light from opposite points of the graduated circle is reflected vertically through the tube that encloses the suspending fibre, to a rectangular prism, by which it is reflected horizontally into the observing telescope.

By this arrangement, images of opposite portions of the divided circle are seen simultaneously in the field of view; and by taking both readings, any error from eccentricity is eliminated.

The observing telescope, the block which surrounds the needle, and the support of the suspending fibre, are all carried upon a vertical conical spindle, free to turn in a socket in the centre of the graduated circle.

In the ordinary use of the instrument, the telescope is fixed in position. In this way readings may be very rapidly made, but in order that they may truly represent the deflections of the needle, the axis of the pencil of light reflected upward from the two mirrors must be exactly vertical. To secure this, it was necessary that the reflecting prism in front of the telescope should be adjusted to reflect such a pencil along the axis of collimation. This adjustment presented some difficulties, but it was finally accomplished by making the axis about which the telescope revolves accurately vertical by means of a delicate level, then, the copper block and needle being removed, a point on the base of the instrument could be seen through the hollow conical spindle, and the prism was adjusted till a point was found whose image remained fixed upon the



THE MAMMOTH TANGENT GALVANOMETER AT CORNELL.

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cross hairs of the telescope as this was revolved about the vertical axis. The needle being now replaced, the mirrors attached to it are adjusted to bring the graduations into the field.

The readings have still to be corrected for the refraction of the glass sides of the box which protects the mirrors from currents of air, and for the torsion of the suspending fibre. The necessity for these corrections may be avoided by turning the telescope, and with it the box enclosing the mirrors, and the support of the suspending fibre, through the angle that the needle is deflected, before taking the reading. For this purpose a pointer is attached to the support of the telescope, and moves with it in front of the graduated circle. By turning the telescope till this pointer appears on the cross hairs, the corrections spoken of above, and all errors due to want of accurate adjustment of the optical part of the apparatus, are avoided.

The instrument is mounted in a building free from iron or other causes of irregularity in the earth's magnetic field; but since the intensity of this field is continually varying, it is necessary that it should be determined whenever the instrument is used for any work requiring high precision. This is accomplished by the method proposed by Sir Wm. Thomson. A coil one metre in diameter, of 100 turns of No. 18 copper wire, wound in a groove accurately turned in a light brass ring, is suspended by a single wire of phosphor-bronze, about two metres in length, from a torsion head whose circle, 10 inches in diameter, reads to 10 seconds. This coil is so placed that the needle is at its centre. A mirror is fixed to the coil, and a telescope and scale at a distance of about three metres, provides for the precise determination of any movement. To observe for H, a current is sent through the coil sufficient to produce a convenient deflection of the needle. The torsion head is now turned to bring the coil into the magnetic meridian. The movement of the torsion head required is about half the deflection of the needle. The determination of H, of course, depends upon a knowledge of the torsional force of the wire supporting the coil. It is important, therefore, to determine this force and its changes from variations in temperature or other causes, with extreme precision. The suspended coil weighs about five kilograms. The wire selected will support 25 kilograms without breaking. Its torsion force is not likely, therefore, to change from any stretching due to the weight of the suspended coil. For the determination of the torsion force, an inertia cylinder was constructed, having the same weight as the coil and arranged to be suspended *in the place of* the latter, with the axis of the cylinder in line with the suspending wire. To insure homogenity, the cylinder was made from discs of sheet brass. Its moment of inertia is upward of 38,000 c. g. s. units. That of the mirror, which is 54 mm. diameter and 3 mm. thick, is only 56 units. The hook and other parts of the suspending apparatus are so small that their moment of inertia cannot possibly amount to 10 units, and this might, with very little error, be omitted. It has, however, been estimated as nearly as possible, and allowed for. The time of vibration of this cylinder has been determined by upward of 100 observations, covering such ranges of temperature as have existed during August and the first week of September. The time is about 16.8 seconds, and the determinations for all amplitudes, from a few minutes to 90 degrees, never vary for the same temperature by more than a few ten thousandths of a second. The law of variation for temperature has not yet been deduced, but the observations indicate no irregularities.

To determine whether a current passing through the wire would produce any effect on the force of torsion, a fine platinum wire, filed to a sharp point, was attached to the centre of the bottom of the weight and allowed to dip in mercury; by this means a current somewhat larger than the maximum that could be used upon the coil was sent through the wire. No difference in the time of vibration could be detected, whether the circuit was closed or open, but an unexpected result was manifested: Although the wire was fine and exactly in the axis of rotation, and dipped only 2 or 3 mm. into the mercury, it offered such a resistance to the motion that the weight would scarcely continue in vibration for two hours, while with the mercury removed the amplitude was still considerable after 48 hours vibration. With the point in the mercury as the amplitude diminished, the time of vibration diminished until it was more than three hundredths of a second less than the normal amount for that temperature.

The force of torsion known, the observations for H are the work of only a few minutes. The extremely slow vibration of the suspended coil made the operation at first a very tedious one, but by the use of variable resistances, and suitable keys in the circuit of the coil, it was found possible to adjust the torsion head and bring the coil very quickly to perfect rest in the magnetic meridian.

The instrument can also be used as an electro-dynamometer by dividing the current between the stationary and suspended coils in such proportion that their differential effect upon the needle is null, and then measuring the effect of these currents upon each other.

Physical Laboratory, Cornell University,
Ithaca, N. Y., September, 1885.

THE TELEGRAPH SITUATION.[1]

PUBLIC attention has been again drawn to the situation of the telegraph lines of the country by rumors of a settlement between the Western Union Telegraph Co. and the telegraph organization conducted by the Baltimore and Ohio R. R. Co. The controversy on this subject between Mr. Garrett, of the Baltimore and Ohio, and the representatives of Western Union, Messrs. Field and Green, does not leave a very clear impression as to its actual origin and merits. The first rumors of an arrangement of the existing telegraph competition arose simultaneously with the announcement of the Vanderbilt-Pennsylvania treaty. It was evidently part of their arrangement that the joint influence of the contracting parties was to be exerted in preventing the Baltimore and Ohio R. R. Co. from obtaining a line into and terminal facilities at New York. The New Jersey Central R. R. was the road which the Baltimore and Ohio have intended to use for this purpose. The story at once took the shape that Mr. Jay Gould, as representing the present Western Union management, had obtained a controlling interest in Jersey Central, and was in a position to turn the road over to Baltimore and Ohio in return for their withdrawal as a competitor to the Western Union in the telegraph field. Mr. Cyrus W. Field, an active director of Western Union, and Mr. Robert Garrett, president of the Baltimore and Ohio R. R. Co., were in London, and it became noised about in Wall street that negotiations were being conducted between them, as representatives of their companies, through the mediatorship of Mr. John Pender, M. P., who is in a manner connected with the Western Union company. It was even stated that they had progressed to an agreement by which the Baltimore and Ohio wires were to be leased to the Mutual Union Telegraph Co., an organization owned by Western Union. There is nothing in the existing conditions which rendered this improbable. The general belief, which does not seem far out of the way, is that the Western Union system, both as to extent and capitalization, has reached a point where further severe competition cannot fail to prove disastrous to its earning capacity. The vigorous attempt in which it had just been engaged to cripple one of its small competitors, the Bankers and Merchants' Telegraph Co., also tended to confirm the impression that its controlling influences were disposed to use every exertion to remove the competition of its chief rival. The reported

1. *Bradstreet's.*

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agreement, coupled with further statements that Mr. Garrett was disappointed with his telegraphic experiment, and that there was a deficit to the Baltimore and Ohio R. R. Co. of $50,000 per month from the operation of the wires, was widely circulated and found considerable belief. Mr. Garrett was cabled, and authorized a denial that any such arrangement was contemplated. The circulation of the reports, in spite of more emphatic denials on his part, finally resulted a few weeks ago in the publication by both parties of the cabled correspondence. There are two views to be taken of the matter so far as it has been made public. Mr. Garrett's denials, and those of Mr. Bates, president of the Baltimore and Ohio Telegraph, that they have any intention of entering into a combination of any kind with Western Union, and that they propose to maintain the independent attitude of the Baltimore and Ohio Telegraph, is entitled to more weight than is usually accorded to utterances of this nature. It would, therefore, seem that the matter is the result of a characteristic indiscretion on the part of Mr. Cyrus W. Field. On the other hand, there is still a possibility that while the reports are premature, they represent the first stage of a negotiation by which the competition of the Baltimore and Ohio lines may ultimately be done away with, either by absorption or pooling with Western Union.

It is this possibility which brings the telegraphic question again into prominence as a pressing social problem. To recount the growing importance which the telegraph bears in our national development and existence is not requisite. Considerations of the greatest magnitude demand that electric communication should attain the maximum of speed and efficiency with the minimum of cost to the individual. So far it has been left to private enterprise, which in a measure has met the requirements, but whether it can supply the increased demands of the public under its present organization, is questionable. It is particularly doubtful whether in the matter of cost of the service the needs of the public are sufficiently conserved. They certainly would not be in the absence of competition.

The Western Union Telegraph Co. is of all the corporations of the country the one having the most extended field of operations, and the one with which the greatest proportion of individuals are daily brought in contact. It extends into every state and territory, and has offices in every city or town of any importance. Its development as a system of wires has kept pace with that of the railroads, with which it has been its policy to maintain the closest alliance. The greater proportion of its lines run along the railroad tracks. Under varying conditions the general form of the contracts with the railroad companies is that Western Union shall maintain and operate the telegraph, having exclusive right to commercial messages at all stations, free transportation of men and material for the erection and maintenance of its wires, and room for telegraph offices in all stations. The railroad company, on the other hand, receives the use of such wires as may be necessary in the direct operation of its road and running of trains, together with a certain amount of free telegraphy for the general business of the railroad company. In some instances part of the expense of the telegraph is met by the railroad, but the general features of the agreements are as stated above. To hold this connection with the railroads has been the fixed policy of the Western Union company. The greater proportion of the roads are included in such arrangements.

As a corporation it grew up from a small organization, and by a process of absorbing other companies, and leasing or erecting new lines in connection with the railroads, its system commenced, about the period of the civil war, to assume something like its present extension. From time to time other competing companies were formed, but by various means they were all absorbed, and their lines made part of the Western Union system. About 1878–9 it met the most severe competition that it had experienced up to that time. Mr. Jay Gould had been interested in a company, the Atlantic and Pacific Telegraph, previously absorbed by Western Union under a pooling arrangement. Apparently he had formed his own ideas of the vulnerability of the latter. He therefore became the prime mover in the formation of the American Union Telegraph. This organization was largely modeled upon the Western Union, and endeavored to follow the same tactics. At that time there remained a considerable mileage of poles and wires still owned by various railroad companies, and either operated independently or merely held by Western Union on terminable leases. Wherever it could be done, American Union secured control of these lines, and by the erection of a considerable number of new ones, soon had a system which reached a proportionately greater number of points and covered more territory than any previous competitor of Western Union. The competition between the companies was of course fierce, and resulted in a substantial decrease of rates over all the territory into which it extended. Western Union was at that time under Vanderbilt control. Its total stock amounted to $41,000,000, while its lines consisted of some 85,000 miles of poles and 230,000 miles of wires, with 9,000 offices. The stress of competition upon the company, however, resulted in the retirement of the Vanderbilt interest in the latter part of 1880, and the securing of the control by Mr. Gould. Immediately after, in January, 1881, a consolidation was effected by which the lines of the American Union, as well as the Atlantic and Pacific (which had been maintained as a separate organization, although pooled with Western Union), amounting together to about 100,000 miles of wire, were transferred to Western Union. The bonds and stock of the American Union to the amount of $15,000,000 were converted into Western Union at par. The $14,000,000 of Atlantic and Pacific stock was also exchanged at 60 per cent. of its par for Western Union stock, and $15,000,000 of new stock was distributed to the holders of the then Western Union stock. This increased the capitalization of the company from $41,000,000 to $80,000,000; the mileage of poles to 110,000 miles, and the wire to 325,000. The ground was immediately taken by Mr. Gould that, having virtually secured the entire control of all the wires operated in connection with the railroads, no company could ever successfully compete with Western Union. Rates were at once approximately restored, although in some instances the competitive rate had become such a fixed public institution that no change was made.

The natural result of this stock-watering and consolidation was a new crop of competitors. The principal one was an institution known as the Mutual Union Telegraph, which, organized and constructed with vigor, soon had a passable system to most of the important northern and western points. It, however, labored under the disadvantage of having no connection with the railroads, its lines being almost entirely constructed across country. After a short-lived competition it too was absorbed by Western Union, under a guarantee of 6 per cent. interest upon its capitalization of $7,500,000. Two other concerns, the Bankers and Merchants' and the Postal Telegraph companies were also organized and are still in existence, their systems reaching only the large cities north of the Potomac and Ohio rivers. The troubles of the former company are still fresh in the public mind, as well as the characteristic attempt a few weeks ago by the Western Union company to prevent the reorganization of the company and seize its wires. The Postal company presents several new features of construction, the most important being the adoption of a greatly improved form of wire, by the use of which it is expected the process of transmission will be facilitated and the cost reduced. Mr. J. W. Mackay, having entered upon the transatlantic cable enterprise known as the Bennett-Mackay cables, in opposition to the existing cable monopoly to which Western Union acts as a feeder, found it neces-

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sary to have control of a telegraph system to all important points connecting with his cables. Some time ago he became heavily interested in the Postal company. The financial organization of the concern was, however, defective, its capitalization having been upon an inflated basis, and its growth has consequently been greatly retarded. It is now undergoing reorganization, the intention being to combine its line with those of the Bankers and Merchants' company under the title of the "United Lines Telegraph." The unsatisfactory state of their business renders it impossible to give the mileage of the two concerns with accuracy. It is, however, somewhat less than that of the Baltimore and Ohio Telegraph.

The latter organization is at this moment the only serious competitor of the Western Union. The ownership of the telegraph lines built by the Baltimore and Ohio Railroad Co. along its road had always been retained by the railroad company itself. They had been operated in connection with the American Union so long as it continued a competitor of Western Union. When the consolidation of American Union with the latter company took place the railroad company resumed control of its wires, and soon after resolved upon extending its operations to a field outside of its railway lines, and building its telegraph lines to all important points, independent of the great telegraph organization. The Baltimore and Ohio Telegraph Co. was accordingly instituted as a separate corporation, the control of course being vested in the railroad company. Its lines already extended, with the ramifications of the Baltimore and Ohio railroad, to Cincinnati, Chicago and St. Louis. Extensions have been built to New York, Boston and other points, and different lines acquired when practicable. Among the latter class are the telegraph line along the West Shore and Nickel Plate roads, forming a second line between New York and Chicago. At the present time it has offices at almost every important centre in the eastern and middle states, and in the western states east of the Mississippi, with the exception of St. Paul, while a line via Texas gives it a connection with New Orleans. It has in round figures about 7,000 miles of poles and 50,000 miles of wire, which, in the absence of explicit reports, may be taken to have cost, according to the best attainable information, something less than $5,000,000. This capital has been furnished by the railroad company, and is represented by stock of the telegraph company held by it. The expressed intention of the management has been to extend it to all the remaining important centres of the country. So far as possible it is operated in unison with the Postal and Bankers and Merchants' companies, the three organizations affording each other all possible facilities in reaching points not common to their systems. Indeed, an arrangement was entered into over a year ago by which the three systems were to be pooled as to earnings, and divide the work of extension so that it might be prosecuted more rapidly. This agreement, however, fell to pieces from the inability of the Postal and Bankers' companies, owing to their financial difficulties, to carry out the latter portion of it.

Within these geographical limits the cutting of rates has become severe. The policy adopted by the Western Union is to use the Mutual Union Co., which is owned by it, and which has offices in all the chief cities affected by competition, to meet the cuts made by Baltimore and Ohio. The object of this is to prevent their own company from making too bad a showing. Thus the Baltimore and Ohio rates from New York to Boston, Chicago and St. Louis for messages of ten words are 10, 15 and 20 cents respectively. The Mutual Union rates are the same, but the Western Union rates are maintained at 25 cents to Boston and 50 cents to Chicago and St. Louis. The Baltimore and Ohio rates to Philadelphia, Baltimore and Washington are uniform with that to Boston. Rates to intermediate competitive points have been reduced to the same or proportionate rates. In this way a number of the centres of the country are provided with competitive telegraphy at low rates. The effect upon Western Union's earnings is marked. The assertions made by Western Union officials that the business of Baltimore and Ohio is conducted at a monthly loss of $50,000 cannot be accepted. It has been denied by the officials of Baltimore and Ohio under oath, and the truth apparently is that the latter, if not profitable, incurs but small loss. The reason assigned by Western Union for maintaining rates is that the service which their most perfect organization performs commands the higher rate. It must be owned, however, that the service of Baltimore and Ohio is approaching, if it has not attained, an efficiency approximating that of Western Union. It is by reason of insufficient organization that the low rates made by the Postal and Bankers and Merchants' companies do not appreciably affect the situation.

To non-competitive points, however, no measurable reductions have been made. Southern points, for instance, between Washington and New Orleans, are now altogether dependent upon Western Union service, an organization known as the Southern Telegraph Co., which extended to the leading cities as far as Atlanta, and which had been controlled by Bankers and Merchants', having passed on the collapse of that concern to Western Union. Competition fails to reach over 25 per cent. of the entire telegraph business of the country, which includes a large proportion of the smaller offices. The present 110,000 miles of poles and 450,000 miles of wire operated by Western Union following the lines of railroads enable it to reach all minor points. While it is true that such business is not profitable like the volume of business that comes from the great cities, the public served at such stations have a right to as little discrimination against them as there is in the mails. The policy of Western Union in reference to rates has not always been based upon an enlightened selfishness; indeed, it has practically been to maintain rates at as high a point as the traffic would bear without inviting immediate competition.

These considerations, and many involved with them, constitute a problem the practical solution of which will be forced upon the public. The English example of incorporating the wires into the post-office is not so inapplicable to our conditions as is often asserted. The reduction of the English uniform rate from 12d. to 6d., or 12c., is an experiment in cheap telegraphy, the result of which will go far to establishing a favorable sentiment toward such a programme on this side of the Atlantic. While circumstances here might not favor a complete uniformity in the cost of telegraphic communication over the whole country, an equitable arrangement of the matter is not impossible. Joined to this question is that of the control of the cables, the international importance of which is not entirely appreciated, and which might become the proper subject of ownership by the nations they serve to bind together.

POWER REQUIRED ON ELEVATED RAILROADS.

A TEST of a locomotive in operation on the Third avenue elevated railroad, New York, was recently made by Mr. Angus Sinclair, and described in the *Car Builder;* the engine drawing the usual load of a train of four cars weighing some sixty-six tons, over its route of 8½ miles, making twenty-five stops. The engine weighs 24 tons; cylinders, 11 in. by 16 in.; average indicated h. p., 163.4; running time, 20 minutes; stopping at stations, 22 minutes. The effect of the great number of stops is shown in the fact that the average train resistance reached 42 lbs. per train-ton, which is about five times the estimate of the pull on the draw-bar if the motion of the train could be continuous. The average horse-power exerted by the locomotive, including time and stations, is 77.8; and as there are 63 trains on the road at the same time, there is an aggregate expenditure of 4,901 h. p. on the road. The evaporation of the boiler on the basis of all coal used, without making any allowance, was 7.4 lbs. water per pound of coal; and the hourly consumption of coal was 5.8 lbs. per h.p.

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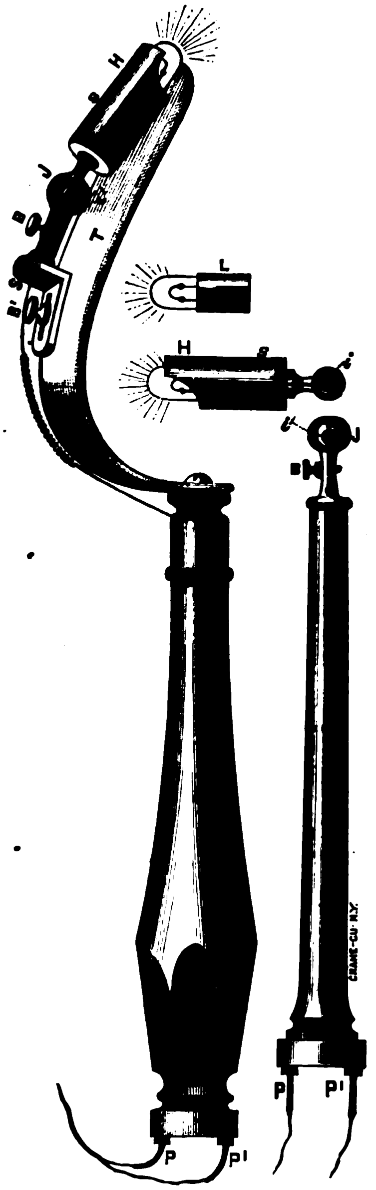
THE ELECTRIC LARYNGOSCOPE.

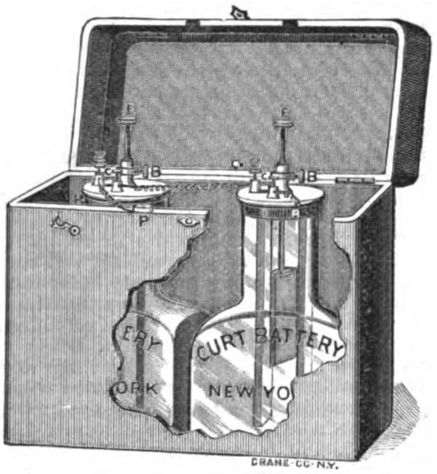
Electricity has gained another apparently permanent foothold in medical practice by the introduction of the miniature incandescent lamp for the purpose of examining such parts of the human body as necessarily require artificial illumination. Either the Laryngoscope or Universal Illuminator, as shown in the cut, are adapted for all possible requirements, and their value in this field must be apparent to every practitioner. In the laryngoscope the tongue depressor, T, is provided with an insulating handle through which pass the conducting cords P and P′. The incandescent lamp L is mounted and set in the shield tube, H, which is a non-conductor of heat. Being connected with



The Laryngoscope—Universal Illuminator.

its support by means of a ball and socket joint, adjustable by set screws, as will be readily understood by its construction as shown in the cut, any desired movement is provided for. By slightly turning the tube H, the circuit may be broken at i^1, when the lamp may be readily removed, and placed in another insulated handle, or in the Universal Illuminator at J. A duplicate mounted lamp, also a mouth mirror with handle, complete this set of instruments, which are packed in a pocket case. All are substantially made and finely finished and are now an indispensable part of a medical or dental outfit.

As yet no battery has been produced so thoroughly adapted to this class of work as the carbon and zinc couple which is usually actuated by a bichromate solution. An improved form of the Grenet battery has been devised by Mr. Meyer, which he calls the "Curt battery," in which he has avoided many of the defects existing in the ordinary portable forms for medical use. The battery has been specially devised to supply the exact current required to develop the full illuminating power of the lamp without danger of destroying the carbon filament. The carbons are corrugated on their inner surfaces, thus enlarging and roughening them. The glass jar is square below and round on the top, holding almost twice the amount of fluid as an ordinary Grenet cell. There is a groove around the upper part holding an elastic ring, over which a rubber cap fits tightly. The carbon clamp is thoroughly faced with platinum, and all parts of the battery are interchangeable. A single charge is sufficient for 150 ordinary applications. Such a battery is of course thoroughly adapted to other uses, such as operating an induction coil, or an electro-magnetic mallet, or charging a secondary battery. The instruments and battery are manufactured by Curt W. Meyer, 357 Fourth avenue.



The Curt Battery.

THAT TEXAS TELEPHONE.

Occasional paragraphs have appeared in the daily papers during the past few months, regarding a wonderful electrical instrument which had been invented by Fred. H. Brown, of Fort Worth, Texas. The descriptions given indicated that it was a simple magneto telephone, which, as is well known, requires no battery to operate it, although better results are obtained by using it as a receiving instrument in combination with a battery transmitter. Considerable interest has been awakened regarding Mr. Brown's invention by reason of the following story which was copied in the New York *Sun* of September 15:

TO REVOLUTIONIZE TELEPHONING.

THE WONDERFUL INVENTION THAT CAME TO A FORT WORTH MAN IN THE DEAD OF NIGHT.

(*From the Fort Worth Democrat.*)

Over three years ago Fred. H. Brown began the work of studying out to an invention an idea which had come to him, that a telephone and telegraph instrument could be made which would work without a battery. For three years he toiled and thought, but seemed no nearer the goal than when he started, until one night in February last, about two o'clock in the morning, he awoke suddenly from sleep and found the invention in his mind. Cold as it was, he jumped out of bed, lighted a lamp, and began to work. In a few months he had perfected an instrument and tried it at home. He at once determined to go to New York; but before his departure sold the right to England to Messrs. George J. Frankel and G. H. Shuttler; to France and Germany to W. E. Keye, who a week later accompanied Mr. Brown east.

The electricians of Mr. Gould and Mr. Mackay inspected the invention carefully, and then the Western Union Telegraph Company and Bell Telephone Company sent men to Washington to see if the method could not be patented; but Mr. Brown had provided against all contingencies, and had patents covering everything. The immense value of the invention was seen by J. J. Safeley, a capitalist, who brought it to the notice of Austin Corbin, a millionaire. He formed a company, and through Mr. Safeley bought the right to the United States for one million dollars, paying $250,000 to Mr. Brown in cash and giving ample security for the payment of $750,000. Mr. Brown returned to Fort Worth early this week, disposed of his property here, and

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on Thursday night left with his family for New York, where he will reside.

When he left New York bonanza Mackay was negotiating for Canada, which is held by the inventor at $1,000,000. Mr. Brown also brought word that a wealthy man wanted England, and was willing to pay a large sum for it, which will induce Messrs. Frankel and Shuttler to go east in thirty or sixty days to look after their interests. Mr. Keye, the owner of the right for Germany and France, is now in New York, and will leave in a few days for Europe.

When Mr. Brown reaches New York a cable test will be made over 5,800 miles of cable, twice the distance across the Atlantic. Instruments for this test will be completed early next week. A test was made in New York not long ago over 800 miles of wire, and the instruments worked as clear as a bell. In a few days 100 miles of wire will be stretched on Long Island for tests of all descriptions.

As soon as possible the company in New York will get to work and organize sub-companies in all the states, when a revolution in telephoning and telegraphing will surely result.

The invention is a magneto telephone and telegraph without battery—a new system of transmitting the sound of the human voice without using batteries of any kind. Brown has had a hard time perfecting his invention, being refused aid by those to whom he applied. A short time ago Edwin F. Masterson, a lawyer of means, and well acquainted with prominent eastern telegraph and telephone men, saw the instrument tested and at once wrote to a director of the Western Union Telegraph Company and President of the Overland Telephone Company, setting forth the wonderful workings of the invention. The Western Union official went to Gen. Charles A. Tinker and asked him to issue instructions to some experienced manager in or near Fort Worth to have the instrument tested over the Western Union lines and to report to him at once. G. J. Frankel, manager here, received the instructions and ordered the Cleburne manager to assist him. In the afternoon of June 21, at 1 o'clock, Mr. Frankel, Mr. Brown, the inventor, Mr. Masterson, J. H. Murphy, Robert L. Moore, operators, and a newspaper reporter were in the Fort Worth office. Mr. Granger, an electrician, and C. M. Bander, manager at Cleburne, were in the Cleburne office. The batteries on the line were cut off from the wire thirty-eight miles long, and the magneto transmitter and receiver attached at both ends of the line. For two hours the test went on, all parties talking, and J. H. Murphy by tapping on the diaphragm of the instrument telegraphing to the Cleburne operator and receiving an answer in the same manner. The voices of the Cleburne parties were very distinct, and a marked feature was the absence of all foreign noises interfering with and incident to other systems.

The instrument used was composed of two ounces of wire and a half pound of steel, and can be made for twenty-five cents. The transmitter is simply a horse-shoe magnet, either pole being covered with fine wire coiled carefully. The armature is a disc of steel against which the voice is thrown, then transmitted through the magnet to the wire. The receiver is similar, but has a smaller magnet. It is claimed by the inventor that he can transmit the voice around the world or across the Atlantic ocean, there being no limit as far as distance is concerned, all that is necessary being the increasing of the size of magnets.

In order to show how little foundation there is for such gigantic financial transactions as are mentioned in the article quoted above, we have reproduced the patent specification and claims, in order that our readers at least, may satisfy themselves as to the practical value of the invention described.

UNITED STATES PATENT OFFICE.

Fred. H. Brown, of Fort Worth, Texas.

MAGNETO-ELECTRIC TELEGRAPHY.

Specification forming part of Letters Patent No. 324,746, dated August 18, 1885. Application filed March 2, 1885. (No model.)

To all whom it may concern:

Be it known that I, Fred. H. Brown, a citizen of the United States, residing at Fort Worth, in the county of Tarrant and State of Texas, have invented a new and useful Improvement in Magneto-Telegraphs, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to an improvement in magneto-telegraphs; and it consists in the peculiar construction and combination of devices that will be more fully set forth hereinafter, and particularly pointed out in the claims.

My invention has for its object the transmission of telegraphic or telephonic messages between distant points by means of induced currents produced by the use of permanent magnets and without the use of a battery-current.

The accompanying drawings represent instruments by means of which I am enabled to carry my invention into effect.

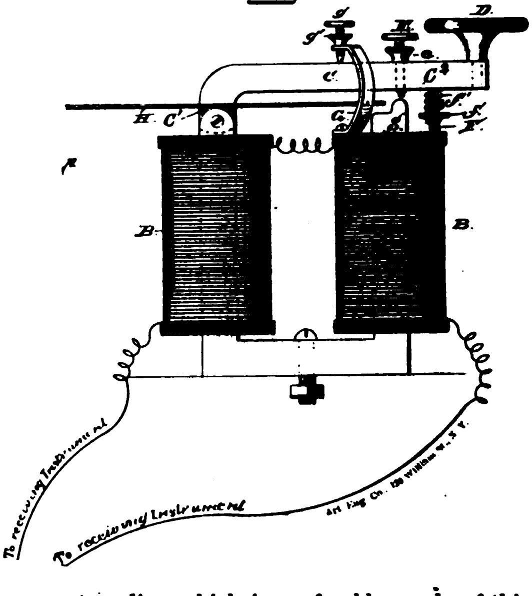
Figure 1 is a side elevation of a sending-instrument. Fig. 2 is a vertical sectional view of a receiving instrument. Fig. 3 is a horizontal sectional view of the same, taken on the line x x of fig. 2.

A represents the sending-instrument, which is composed of a permanent U-shaped magnet, on the poles of which are wrapped the helices of insulated wire B. A key, C, is pivoted to one pole of the magnet, and extends over and beyond the opposite pole thereof, and is provided at its outer extremity with a button, D, similar to the telegraphic keys now in common use. The pivotal end portion, C', of the key is made of soft iron, and the extended arm portion C^2 thereof is made of brass.

E represents an adjusting screw, which is made of iron, and which passes down through the key C, its lower end being normally nearly in contact with the pole S of the magnet. The adjusting screw E is provided with a jam-nut, *e*, as shown.

F represents a brass screw that projects from the upper side of the south pole of the helix. On this screw is placed a thumb-nut, *f*, which is internally threaded to receive the screw, and which is adapted to be adjusted up and down upon the screw F. A coiled spring, f', bears between the upper side of the nut *f* and the lower side of the key, and prevents the screw E from coming normally in contact with the south pole of the magnet. A curved arm, G, is made of brass, and is secured to the upper side of the south helix, and down through the upper end of this arm is passed a regulating or adjusting screw, *g*, which has a jam-nut, *g*, and limits the upward movement of the key.

Fig. 1.



H represents a disc, which is preferably made of thin sheet-steel, and which is permanently secured to the pivoted end of the key and extends horizontally over the poles of the magnet, as shown.

Z represents the receiving-instrument, of which I represents an inclosing-case, which is composed of wood or metal, and is provided with a mouthpiece, K. To the lower side of this case, on its inner side, is secured a permanent U-shaped magnet, the south pole of which is at one side of the inclosing-case, while the north pole is directly in line with the centre of the case and its mouth-piece. On the north pole of the magnet is wound a helix, L, of fine insulated wire, while the south pole is left bare. The ends of helix L are secured to the binding-posts M, and the wires from the sending-instrument are connected to said binding-posts, as shown.

N represents a circular metallic band having projecting points, *n*. This band is placed in the inclosing case, in the upper side thereof, at a suitable distance below the contracted inner end of the mouth-piece, and is secured to said inclosing-case by means of screws, which pass through openings in the outer ends of the projecting points, and secure said points in recesses that are made in the inclosing-case to receive them, as is shown at fig. 3. By this construction an air space is left between the band and the inclosing-case.

On the under side of the band N is secured a disc, O, which is preferably made of thin sheet-steel, and which is acoustically insulated from the band N by a piece of paper or other suitable substance, P, that is interposed between the disc and its supporting band. The south pole of the magnet is in contact with the north pole or outer edge of the magnetized disc, and the north pole of the magnet is directly under the centre of the disc and out of contact therewith.

By this construction it will be plain that the centre of the disc O is free to vibrate. By securing the disc in the inclosing-

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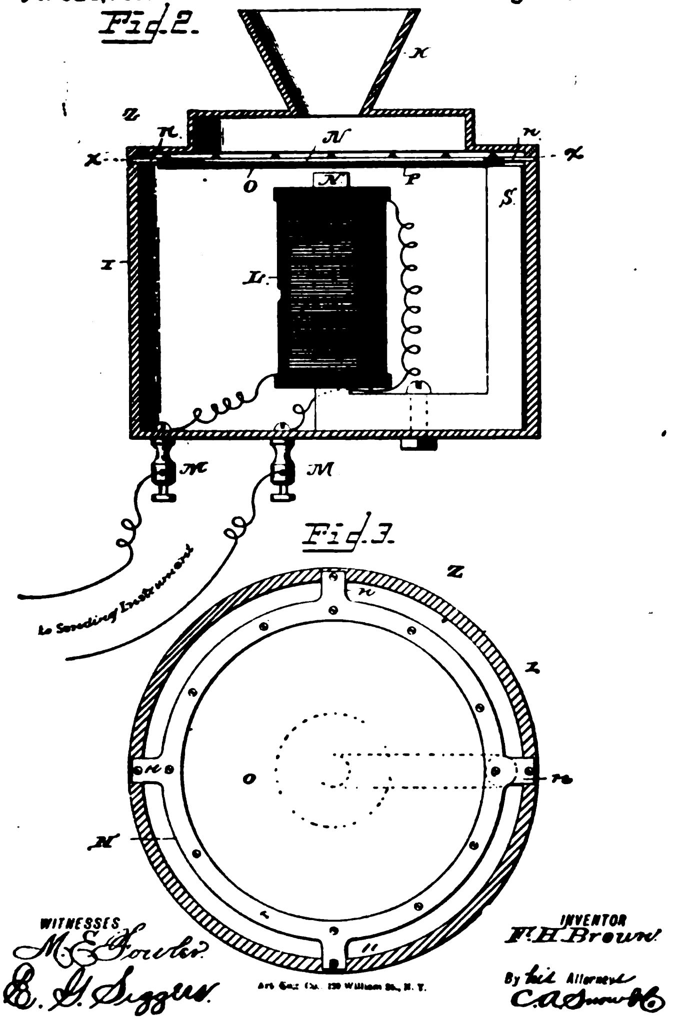
case so as to leave an air-space around the outer side of the disc, between it and the inner side of the inclosing-case, the air-chamber formed by the inclosing-case is in communication with the air-space in that part of the inclosing-case above the disc.

The operation of my invention is as follows: The key of the sending-instrument is operated so as to tap off the dots and dashes used in the telegraphic code (Morse). As the key is depressed it comes in contact with the south pole of its magnet, and thus closes the magnetic circuit, and the jar consequent upon this impact sets the disc, which is secured to the key, in vibration in consonance therewith, and produces a resonant tone. The vibration of the sending-disc induces an electric current instantaneously of great kinetic energy and intensity, but of short duration, which is transmitted through the connecting-wires to the receiving-instrument, and the vibrations of the sending-disc are reproduced by the disc in the receiving-instrument. The vibrations of the receiving-disc are communicated to the air in the inclosing-case, and this air-chamber being in communication

F. H. BROWN

MAGNETO ELECTRIC TELEGRAPHY.

No. 324,746. Patented Aug. 18, 1885



with the external air the air in said chamber acts as a resonator, and conveys clearly to the ear of the receiving-operator the signals made by the sending-instrument.

I do not desire to limit myself to the precise construction hereinbefore described, as it is evident that many modifications may be made therein without departing from the spirit of my invention.

By placing an inclosing-case around the disc at each end of the line, and by providing these inclosing-cases with suitable mouth-pieces, the instruments are adapted for the transmission of articulate sounds.

In fig. 2 I have shown the receiving-instrument with only one helix on its magnet, which is all that is necessary if the instrument is to be used merely as a receiving-instrument; but if it is adapted for use both as a sending and receiving-instrument or as a sending-instrument, its magnet will be provided with two coils.

Having thus described my invention, I claim—

1. The combination of a permanent magnet having a coil or coils, an armature or disc connected to one pole thereof and free to vibrate over the opposite pole, and a key for vibrating the armature or disc, substantially as described.

2. The combination of a permanent magnet having a coil or coils, an armature or disc connected to one pole thereof and free to vibrate over the opposite pole, a key for vibrating the armature or disc, and stops for limiting the play of the key, substantially as described.

3. The combination of a permanent magnet having a coil or coils, an armature or disc connected to one pole thereof and free to vibrate over the opposite pole, a key for vibrating the armature or disc, and a spring for keeping the key normally out of contact with the disconnected pole, substantially as described.

4. The combination of a permanent magnet having a coil or coils, an armature or disc connected to one pole thereof and free to vibrate over the opposite pole, a key for vibrating the armature or disc, a spring for keeping the key normally out of contact with the disconnected pole, and stops for limiting the play of the key, substantially as described.

5. The combination of the permanent magnets having the coils connected in circuit, an armature or disc connected to one pole of each magnet and free to vibrate over the opposite pole thereof, whereby the vibrations of one of the armatures or discs are transmitted by induced current to the other armature or discs in circuit and reproduced by said other armatures or discs, and an inclosing-case forming an air-chamber around the disc or armature of one or each of the connected magnets, said inclosing-case having a mouth-piece, substantially as described.

6. The combination of the permanent magnets having the coils connected in circuit, an armature or disc connected to one pole of each magnet and free to vibrate over the opposite pole thereof, whereby the vibrations of one of the armatures or discs are transmitted by induced currents to the other armatures or discs in circuit and reproduced by said other armatures or discs, an inclosing-case forming an air-chamber around the disc or armature of one or each of the connected magnets, said case or cases having a mouth-piece, and a key or keys for vibrating the armature or disc of one or each of the magnets in circuit, substantially as described.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in presence of two witnesses.

FRED. H. BROWN.

Witnesses:
C. D. BROWN,
W. A. DARTER.

The following letter, which appeared in the Boston *Transcript*, points out that there is apparently no novel feature whatever in this invention :

BOSTON, Mass, Sept. 17, 1885.

To the Editor of the Transcript: My attention was attracted by an article in the *Transcript* of September 16, page 4, column 7, under the general financial head, entitled, "To Revolutionize Telephoning."

The said article is credited to the Fort Worth *Democrat*, and describes an alleged new departure in the art of telephony, the essence of which is to transmit and reproduce electrically the sounds of the human voice without using batteries of any kind. If we may believe the article in its entirety, this wonderful invention sprang fully armed, Minerva-like, from the brain of Mr. Fred H. Brown, of Texas, and speedily seduced the nice little sum of $1,000,000 from the pockets of a few unsuspecting and guileless New York capitalists.

In an adjacent column a rather sarcastic paragraph alludes to the statement made in London *Truth*, relative to the new penchant of the Americans for boiled water, based upon the doubtful scientific hypothesis that the process of boiling was destructive to the oxygen in the water, which thereby was made more refreshing; and compares that statement with a prior newspaper paragraph cautioning people against drinking aerated liquids because their effervescence was produced by carbonic acid gas.

Yet the display of electrical knowledge in the Fort Worth *Democrat* article is fully as startling, and might with perfect propriety be classed with the boiled water item.

We learn that the transmitter of the new invention is simply a horseshoe magnet, either pole being covered with fine wire coiled carefully; and that the armature is a disc of steel, against which the voice is thrown, to be transmitted through the magnet to the wire; also that the receiver is similar but has a smaller magnet.

Since the telephone was first publicly given to the world by Bell in a paper read before the American Academy of Arts and Sciences, in May, 1876, it has been a common thing for those whose "wish was father to the thought," to deny his inventorship and to ascribe that merit to Reis, Meucci, Cammack, Edison, Gray, Drawbaugh—any one, in fact, to beat Bell. James Watt said that any one making a great invention must pass through three stages in the estimation of the great mass of the public—first, it would be said it was impossible; next, it would be said

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that he had not done it; finally, it would be asserted that it had long been known.

Mr. Bell has experienced to the full the truth of these observations.

It has, however, rarely been the fate of an inventor to see his invention pass into universal public use, and after the lapse of nine years hear that a new and wonderful achievement of science has been produced, which when described proves to be exactly his own idea. Yet such is the case in the present instance, for the description given of Mr. Brown's new telephone describes exactly the telephone of Mr. Bell before the battery transmitters of Edison and Blake were added.

From its first production in 1876 until some time in 1878, every telephone in use was operated without batteries; and the battery transmitter was a subsequent invention, added to increase its efficiency.

The Bell magneto-telephone was described in the *Transcript* of October 19, 1876.

So far as telephony is concerned, therefore, the wonderful instrument of Mr. Brown is almost a Chinese copy of the original Bell telephone.

It is also, however, implied that this instrument is likewise an innovation in telegraphy. Referring to page 538 of "Electricity and the Electric Telegraph," by Prescott, edition of 1879, we find a description of a complete system of magneto-telegraphy, invented by the well-known German electricians Siemens and Halske, which fully anticipates this feature.

Finally, referring to the United States Patent Office records to ascertain what it is that Mr. Brown really invented, we find that the only patent as yet issued to him is No. 324,746, bearing date of August 18, 1885, and entitled magneto-electric telegraphy; and that an analysis of this patent resolves it into a new form of key combined with the use of a Bell telephone in lieu of an ordinary telegraph sounder.

Such a use was anticipated by the patent of Orazio Lugo, issued December 7, 1880.

As to the financial success of Mr. Brown, it is hardly to be believed that men like Mr. Gould or Mr. Corbin, or that corporations like the Western Union Telegraph Company or the Bell Telephone Company could be beguiled into parting with a million of dollars for an invention which five minutes' conversation with a competent patent attorney would show to be scarcely worth so many mills.

Yours respectfully,

THOMAS D. LOCKWOOD.

THE BROOKLYN UNDERGROUND PROBLEM.

THE following is the full text of the Brooklyn Electrical Subway Commission's report:

BROOKLYN, September 15, 1885.

Hon. Seth Low, Mayor of Brooklyn:

The undersigned, appointed by you as commissioners of electrical subways for the city of Brooklyn, organized as a board on the 9th day of July, and have since held twenty-nine meetings, mostly private, and devoted to the study of the problems presented to the board by the law under which it was created. At a considerable number of public sessions, and also by a voluminous correspondence, the views and proposals of experts and inventors have been examined; and the board has, moreover, made itself acquainted, as far as practicable in so brief a period, with the experience of other cities having electrical subways in this country and in foreign countries. The president of the board has made a personal examination of the various underground conduits and systems in use at Washington, D. C., and has consulted freely with those who, during the past few years, have been conducting experiments with electrical subways in that city. Neither these investigations nor the knowledge previously possessed by the individual members of the board have rendered it possible at this early stage to announce a solution of the problem of underground electrical conductors throughout the city of Brooklyn which shall be thoroughly practicable and at the same time entirely satisfactory and complete. One solution has, indeed, been proposed by eminent authority. The general committee on underground communication, composed of telegraph and telephone managers, the governor of the state and the mayor of the city of New York and others, referred the subject of electrical and mechanical devices to a sub-committee, of which a distinguished electrician, president Henry Morton, of the Stevens Institute of Technology, was chairman, and this sub-committee reported in March, 1884, that nothing would be as good as a properly constructed tunnel of sufficient size to admit the passage of workmen and access to the wires within it; this tunnel to be connected with conduits of sufficient capacity for lateral wires. Another sub-committee of the same general committee reported that there was no law of the state under which a company could construct such a tunnel and conduit system, with the view of leasing the space or the conductors; and it seems to be admitted that no existing company would undertake it for the accommodation of its own wires. That the cost would be very great is evident, and the probability is that it would be greater in Brooklyn than in New York, if the attempt were made to cover with such a system all the area of the city, since the shape of our city of Brooklyn would not permit so easily the distribution of lateral conduits from one main, central tunnel.

So far as the board has been able to learn, no extensive tunnel system has anywhere been constructed for the accommodation of electrical conductors. In London, where the tunnels of the Metropolitan Underground Railway have been utilized, and in Paris, where the large sewers have served the same purpose, these subterranean channels, already existing, could be turned to account without cost, and these cases constitute no precedent applicable to a city where tunnels and suitable large sewers do not exist. Such opportunities, and likewise the opportunities offered by the structures of elevated railways should be utilized, of course, wherever practicable. But it does not follow that nothing more can or should be done until somebody constructs a vast system of tunnels and branches. Even if that were certain to be the ultimate plan (of which this board is by no means assured), tangible relief may be obtained in the meantime from plans less ambitious and comprehensive.

The sub-committee already mentioned examined between May 7, 1883, and March 15, 1884, about six hundred proposed plans and devices. Since the latter date many new ones have been brought forward. Their number, variety and complexity would render the task of this board almost interminable if that task were to be an exhaustive scientific examination of every theory or device submitted to it, coupled with experimental tests of such promising ideas as had not received the seal of successful practice. But this board conceives its duty under the law to be to promote in every possible way relief from the evils which the law was designed to remedy, and it has therefore been from the outset desirous of approving some plan by which a beginning could be made, provided only that such a plan should be reasonably free from mechanical or other objections, and that it should not be of such a nature as to exclude improvements dictated by further experience. The consideration of the subject with a view to immediate practical action has been much simplified by the establishment of certain conclusions, based upon actual conditions in the city of Brooklyn, as well as recognized principles of electrical engineering; and it is to state these conclusions and explain in plain and non-technical language the consequent action of the board that the present report is designed.

1. The purely electrical questions connected with underground electrical conductors are not yet satisfactorily solved. The general experience is that such conductors cost more in the beginning and less for current maintenance than overhead wires; but that they do not last as long. No substance used as an insulator underground has proved invariably and perfectly permanent. The expensive gutta-percha covered wires, employed so widely in Europe, have been deemed (apart from their high cost) the best subterranean conductors; and yet wires of this kind —the same as those used by the British postal telegraph— which had been for years in the underground service of the Western Union Telegraph Company in New York have, within a few weeks past, developed a curious dis-

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ease of the gutta percha coat which rapidly destroys their insulation. If material so long and so thoroughly known and tested is thus liable to fail, obviously it would not be safe to trust to materials not known or not tested by prolonged experience, no matter how confident their inventors might be of their special virtues. The practical conclusion drawn by this board from the above proposition is that solid conduits—that is, conduits consisting of groups of wires solidly bedded in insulating material (such as asphaltic concrete or the like), should not be extensively adopted in the present state of knowledge and experience. By this it is not meant that experiments might not be cautiously tried with some such method, but such experiments should be limited in extent and prolonged in duration. Only successful operation for some years could overcome the unfavorable presumption created by past experience. In such solid conduits the single conductors have hitherto almost invariably failed, sooner or later, for one reason or another, or for no assignable reason, and when they do fail the whole agglomeration of wires and cement is useless. Repair is impossible and the digging up of the mass to replace it is far more difficult and costly than the original excavation. In Washington, Philadelphia, New York, even in Brooklyn, there are to-day sections of underground conductors laid on this plan and abandoned in despair, but not removed. The immediate problem is thus simplified by excluding for the present solid conduits, and leaving such only as permit the renewal and removal of wires and cables.

2. It is not primarily the duty of this board to solve electrical problems for the benefit of the electrical companies, and in judging of any system of underground connections proposed by such a company the board is concerned with its electrical features only so far as they affect its repairs or changes, and the disturbance of the city streets which those may involve. That is to say, questions of detail concerning insulators, conductors, preventives or remedies for induction, etc., may be safely left to the companies themselves, their interest being to secure and maintain an efficient service in these respects, provided always that the system proposed be one which will permit experiment, repair, renewal and change without excavation. If the streets must be dug up every time an old cable or wire fails or a new one is to be tried, then it is part of the duty of this board to know beforehand what sort of conductors, insulators, etc., will be used in any proposed system, and to approve only that system which promises in these respects the greatest efficiency and permanence. Otherwise, these considerations concern the electricians and business managers of the companies only. The problem is thus further simplified by restricting it for the present to conduits only.

3. Such conduits, unless they were large tunnels, could in all probability not carry the wires for electric arc lights. No discussing of the electrical disturbance produced by currents of high intensity upon neighboring conductors will be undertaken. Nor does the board here pass a scientific judgment upon various suggested remedies. A number of plans have been submitted to the board involving the collection of telegraph, telephone and arc light wires in the same conduit, of small dimensions. In some cases the inventors evidently do not realize the difficulties and dangers involved; in other cases they offer ingenious remedies and protections, not yet tested in practice. But this board is not willing to approve such plans in the present state of electrical science. It is convinced that prudence requires that the electric arc light conductors should be, in the words of the New York sub-committee, already referred to, "widely separated from each other, from all other classes of conductors and from the walls of the conduit." The second of these requirements is the most important, and it simplifies the duty of the board by dividing one problem into two, which can be separately solved. A large tunnel being deemed at present impracticable, the low tension (telegraph, telephone, etc.), conductors and the high tension conductors must be provided for in different conduits.

4. Approaching now the subject of underground conductors for telegraph and telephone service, the board finds that the most important and in some respects the most difficult part of the problem in the city of Brooklyn is presented by the telephone service. The New York and New Jersey Telephone Company, operating nearly all the telephones within the city limits, owns over two-thirds of the electric conductors of all kinds strung overhead in Brooklyn, and occupies either alone or in conjunction with the other electrical companies and with the city departments nearly three-fourths of the poles supporting such conductors. This company, in round numbers, has 2,400 subscribers in Brooklyn, 1,900 of whom require special separate wires, the remaining 500 being grouped upon circuits, so that one wire serves several subscribers. In a few large business blocks in the neighborhood of the City Hall subscribers are so numerous and are so likely to be always numerous, in spite of individual changes, that the wires distributed to such buildings may be regarded as permanent, and there is no difficulty in arranging for their distribution from subways, without the use of aerial supports. But over the larger part of the city, particularly among residences, telephone subscribers are sparsely scattered. To require that connection should be made wholly underground with each of these would be certainly to raise the cost of the telephone service to exorbitant figures, and probably to destroy the service altogether, for the earning capacity of a telephone wire is limited to a fixed sum. No amount of business done over the wire within the city limits increases the income of the company. The charge in Brooklyn at the present time, for instance, is, for a residence, $60 per annum, and the subscriber contracts for only twelve months at a time. In the spring and fall large numbers of persons change their residences and have their telephones moved; at all times there are new subscribers coming in and old ones falling out. Changes due to these causes have been known to amount to several hundred in a month, and as the business is extended these changes will become still more numerous. If complete underground connections were insisted upon in all cases, the telephone company would be obliged either to exact from its residence subscribers a heavy initial payment to cover the cost of the first connection, or a long contract of service, or both, or else it would decline to serve such subscribers. In practice, either of the two former alternatives would probably be the same as the last, since, if the company did not decline the subscriber would. In the opinion of this board the resulting limitation of the telephone service in Brooklyn would be a serious injury to the city. That service is one of the last invented agencies of civilization by which this city is rendered a desirable place of residence. The means of easy communication between Brooklyn and New York, or between distant portions of this city and its business and official centres, promotes its territorial extension and the increase of residences in its beautiful outlying wards. If handsome dwellings are no longer confined to the Heights, it is because of such conveniences as the bridge, the surface, elevated and rapid transit railways, and last, but destined not to be least, the growing telephone system. The existence of such a system, therefore, is a benefit to others than its subscribers for the time being, just as the existence of gas and water supply in a given street enhances the value of property on that street, even of houses not yet supplied, or of vacant lots where no houses stand.

Another consideration, however, has impressed itself upon this board. Assuming that it were mechanically and commercially practicable to make all telephone connections completely subterranean, and that the telephone company could satisfactorily adjust the question of cost with its subscribers, the perpetual digging up of the streets

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and sidewalks of Brooklyn to make and unmake such connections might become a more intolerable nuisance than the aerial wires. If telephone subscribers were so numerous and so distributed that a main conduit were required in every street, this evil would be reduced to a minimum, though it would still exist. If every house contained a permanent subscriber, or if every house owner maintained the telephone service as regularly as the gas or water service the evil would disappear. But such conditions neither exist nor impend. In the present actual condition of the Brooklyn telephone system, a combination of main subways with overhead conductors, for terminal distribution, is the only thing that can reasonably be undertaken.

Such a combination has been in operation for some years in Washington, D. C., where the cables from the main subways are carried at convenient points to poles, whence the single wires are distributed to subscribers. Washington, fortunately for this plan, possesses numerous lanes and alleys in which such poles can be placed and thus be removed from the main thoroughfares. In Brooklyn, for the most part, such lanes are wanting. In permitting such a system here it would be the duty of the board to exercise a constant vigilance in detail, with the determination of abolishing, as fast and as far as possible, all poles whatever, and of securing the location in the least objectionable places of such as seemed temporarily indispensable.

Immediately upon the organization of the board the New York and New Jersey Telephone Company proposed to lay in Washington street a box conduit of creosoted wood, to contain in separate compartments cables of 25, 50 or 100 wires which would be drawn in through manholes located at convenient points, and would terminate at distributing poles. The board declined at that time to commit itself to the approval of this plan, and required of this company, as of all others operating in the city, the preparation of maps and other information necessary for a full investigation of the subject. A map showing the location of every telephone subscriber and wire in the city was prepared by the company and the minor details of its plan, which was subsequently proposed again on a larger scale, were thoroughly discussed between the board and the experts of the company.

As the result of these inquiries and conferences the board has adopted the following resolutions:

Whereas, The New York and New Jersey Telephone Company has submitted to this board a plan of construction for an underground conduit to contain electrical conductors, which plan the said company propose to carry out immediately on the following lines, viz.: On Fulton street, from DeKalb avenue to the City Hall and below the City Hall, either on Fulton street or on Washington street, to points to be hereafter determined by this board, the said conduit to consist of a partitioned box of creosoted timber, and the wires and cables contained therein to be connected for terminal distribution with overhead conductors at such places and to such extent only as this board may permit;

And whereas, The representatives of the Western Union Telegraph Company and the Gold & Stock Telegraph Company have signified their concurrence in the said plan and their willingness to place their conductors along the said routes in the said conduit, and the said New York and New Jersey Telephone Company has agreed to give in the said conduit sufficient accommodation for the said wires, and also for the wires of the police and fire departments of Brooklyn;

And whereas, The said plan of construction appears to this board practicable, and promises to remove from the said streets a large number of the telephone and telegraph wires and poles which now encumber them; therefore,

Resolved, That this board hereby approves the said plan of construction, subject at all times to such modifications as shall from time to time by this board be made, and subject also to the rules and regulations not inconsistent therewith, prescribed or to be prescribed by the municipal authority having control of said streets. Provided that the number, nature, location and extent of all aerial conductors to be connected with the said subway, and of their poles or other supports, shall be determined hereafter by this board, the present general approval of the said plan, in advance of the determination of details, being given by this board in order to permit making of contracts for the materials required.

A few words in further comment on this action will complete what the board deem it advisable to say at this time. The plan thus approved is subject to the continual control of the board; and the approval thus given does not prevent the board from continuing a patient examination of all other suggested plans. Since this conduit, however, will permit the experimental use of any kind of cable which the telephone or telegraph companies may prefer, the choice of such cables has been left by the board, for the present, to the companies, and the latter have already determined to try several varieties. Persons having special conductors or insulators to recommend are, therefore, referred to either of the above named companies. At the same time, this board will be glad to receive at any time from such persons statements concerning proposed conductors, etc., and will arrange for personal hearings whenever they shall seem to the board desirable. But, pending the tests to be made by the companies, the board does not propose to institute practical tests of new conductors. With regard to the conduit itself, the board is satisfied that timber properly creosoted will be sufficiently durable, and this material having been proposed by the companies referred to, the board has not felt called upon to suggest any other and more expensive one. Creosoted wood is said to be injurious to gutta-percha coating brought into contact with it; and it is not unlikely that wires covered with gutta-percha would have to be further protected if used in this conduit. But lead pipe containing insulated wires can be placed in it without fear of injury from creosote or moisture. Such lead cased cable could be, in the opinion of the board, drawn into the conduit through the manholes, even if the latter were placed at greater distances apart than will probably be the case. The position and detailed construction of the manholes, together with other details of the system, will be determined hereafter, with careful reference to the local conditions on each block affected.

The objection to box conduits, that they may give opportunity for the accumulation of explosive mixtures through leakage from the gas pipes, has been duly considered, and the board believes that effective provision can be made for the prevention of such accumulation in this conduit. A conduit of this character has been successfully operated in Brooklyn during the last nine months. It lies in Court street, from the City Hall to Pacific street; it contains in cables 450 telephone wires, of which about 250 are now in service and the remainder are being rapidly brought into connection with aerial distributing conductors. This conduit has so far given no trouble and has not been opened since it was laid. It is intended to open it and carefully inspect its condition, and such an inspection may determine some points of detail in the larger system of the same general character now to be constructed.

In regulating the terminal distribution connected with the proposed conduit, the board will follow no general and invariable rule, but, considering each locality separately, will strive to reduce to a minimum the necessary amount of aerial conductors, and to cause these to be supported wherever practicable otherwise than upon poles in the streets.

G. W. PLYMPTON,
ROSSITER W. RAYMOND, } *Commissioners.*
JOHN REYNOLDS,

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 338.)

INSIDE CONSTRUCTION.

THERE is perhaps even more chance for a man to show how good or how bad a job he can do, in inside construction, than there is in outside work. In running wires with-

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in a building it is often necessary to conceal them, and this is a serious temptation for the workman who is either unable or will not take pains, to perform nice work.

If wires are not to be concealed they may be made a really fine looking piece of workmanship, and in general when wire construction looks well, it is well done.

The three principal styles of attaching wires in buildings, are stringing upon porcelain knobs, tacking down with small staples, and running the wires through cleats. Each of these plans has its good points, and each has its partisans.

I have known men who would always work upon some one of these methods only—but the best constructors are those who are not prejudiced either in favor or against any plan, but who will avail themselves of that mode of procedure which seems best adapted to the case in hand.

Under some conditions it will be found best to tack the wires; at other times the preferable way is to use the knobs—in still other circumstances the cleats should be employed; while cases often arise in which a combination of all the foregoing styles may profitably be adopted. Sometimes also, where many wires are to be led from point to point it is economical to use cables.

The size of wires used inside buildings, varies with the character of the currents used. In ordinary telegraph systems No. 16 or No. 14 double covered copper is the proper size and kind; No. 18 being somewhat too small for such purposes.

If there are a number of wires, and the point to which they are to be led is some distance from the entering point, they may either be led along the ceiling, or along the wall as is most convenient; the wall may however be of brick, in which event it is a saving both of time and labor to run them on the ceiling; and under the same conditions cleats would be used. Black walnut cleats are the best, and ought to be about one inch deep, and three-quarters of an inch wide. If there are not more than six wires to be carried, a two-inch screw at each end, will suffice to fasten up the cleat; but if there are more than that number a screw through the middle is also required. A cleat should never be loaded with more than four wires unless it is first provided with a hard-wood base. This base may with propriety be about three times as wide as the cleat itself, and about three-eighths of an inch thick. The cleat may

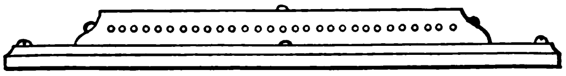

FIGURE 26.

be attached to the base by 1½ inch wood screws, and the base must be screwed to the ceiling by a 1½ inch screw at each corner, and another one about every nine inches, along both sides. Figures 26 and 27 are views representing a based cleat for wires.

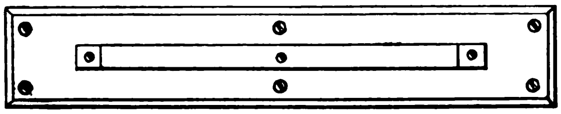

FIGURE 27.

The holes for the wires must be large enough for the size of wire used to pass easily through, and if wire not larger than No. 16 is used, may be as near as three-eighths of an inch from centre to centre. Of course before attempting to screw up the cleats, the position of laths or string pieces should be ascertained, so that each screw may have a bite on solid wood, and not be wasted in the plaster. If more than 24 wires run together, it is more compact and neat to use a cable, which may be fastened to porcelain knobs, or drawn through small brackets with holes about an eighth of an inch larger than the cable itself. To run two wires from point to point there is no better way than to screw porcelain knobs of the kind used in picture hanging, in the wall about an inch and a half below the ceiling or cornice, using two inch round headed screws, and placing them about ten feet apart; when this plan is adopted the "in" wire duly fastened to the incoming line is brought to the top of the first knob, pulled taut, and then given one turn round the knob so as to bring it to the top again; from whence it is passed on to the top of the next knob, and so on from knob to knob, until the last one is reached, when it should be pulled tight and knotted. In like manner the wire connecting with the outgoing line must be run to the lower side of each knob, and given a single turn round each, and it is thus kept parallel to the "in" wire, but about five-eighths of an inch from it, between the knobs. It should be noted that only wire which is well insulated can be run in this fashion, as the wires come together on the knobs; it must also be noted that the wires leaving the last knob must be long enough to be carried wherever desired; and it is always an excellent practice to curl the ends round a pencil, not necessarily for elegance but so that if the wire should break, there would probably still be enough for the requirements. Electric light wires may not of course be fastened in this way. Wires for incandescent lights ought to be run at least two and a half inches apart from one another, and ought to be fixed by porcelain cleats, screwed on to hard-wood base pieces. Wires for arc lights ought to be a minimum distance of eight inches apart, and to be pulled up tight, and fastened in non-conducting supports affixed to the wall. Wires for electric lighting have no business on damp walls, where sooner or later they will give rise to trouble and danger.

Passing through floors, walls, or partitions such wires ought first to be wrapped with unusual care, and then drawn through and surrounded by a tube of some incombustible non-conducting material. Telegraph, telephone or time wires, in fact all wires connected with electro-magnetic systems and instruments, should always be provided with an efficient lightning arrester, placed immediately inside the building, and this should have a stout ground wire, of copper not less than No. 14 gauge. It is hardly necessary to describe that appliance here, as many forms are well-known, are described in text-books, and are on sale at the stores of electrical supply dealers. Telephone wires entering a central station should run first to the lightning arrester, and then to a binding screw or clamp, where they should terminate. Right opposite this terminal should be another, about three inches distant, which in turn is connected with the office wire leading inward; and these wires ought to be connected together by a safety catch or strong current guard which may consist of a thin and narrow strip of tinfoil backed up by being pasted on a card; or a very thin platinum, german silver or lead wire may be used. In New Orleans, at the central telephone office, two wood screws are affixed with a couple of copper burrs at a distance apart of about two inches, and a piece of No. 42 german silver wire is wound round both screws, constituting the safety link—this simple appliance has several times saved the plant from a greater or less destruction due to electric light cross; from this point inward the wires may be led to the switch board by cables.

No central telephone office should in these days of electric illumination fail to be provided with some form of circuit protector—and this device is also equally necessary at the outer ends of cables, and between the instruments and line wire at the subscribers' stations.

The use of wood screws and copper burrs in lieu of binding posts or regular screw connections, is usually regarded as being satisfactory, and being cheap is often preferred. I have found it to work all right, if certain precautions are taken.

The base board upon which the screws are to be inserted must be of thoroughly seasoned wood of medium hardness; if green or unseasoned wood is used for this purpose, it will gradually shrink away from the screws, leaving the wires loose; a washer or burr must also be used between every

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two wires, and great care must be exercised in entering the screws so that they may not be screwed too deep because if screwed up before the wires are all in place, the screw can never be tightened again, but will turn round in the hole. All screw connections of this kind, and even all binding screw connections, should be frequently tried, to ascertain whether they are tight, and connections which are not accessible, or which are to be covered by other wires should always be permanently made by splicing the wires.

Wires run for currents to work printing telegraphs, should always have heavy insulation such as rubber, kerite, or some like, well-tried non-conductor; paraffined cotton unless very thick being hardly sufficient; such wires may be cleated.

Wires for electric bell work may be insulated with cotton, and No. 18 copper will ordinarily do for this purpose, but if to pass through damp places, or over damp walls, sections of rubber or kerite covered wire must be used.

Where dry wooden walls or partitions are accessible, the wires except for temporary installations may be tacked down, but it is a sign of either recklessness, carelessness or ignorance to place any two wires at any time under the same staples. Heavy risk of short circuiting always attends such a practice which should never be suffered.

In running office wires, where there are several, and where it is requisite that each shall be distinguished from the others, each wire should be insulated by a different colored covering.

It is not within the scope of this series of papers, and indeed it is hardly necessary in view of the numerous text-books referring to the subject, to describe the arrangement of ordinary telegraph instruments; and it seems, therefore, sufficient to say that in establishing a new station or office the main line wires must be united by a cut-out, until the instruments are all in place and connected; that if the operating table is covered by an oilcloth, a space must be cut for the key, to prevent escapes; that both main line wires entering, must be led first to the lightning arrester, then passing through the cut-out, one wire must be continued to the key, and the other to one post of the relay, the other binding screw of the relay being connected by a separate wire to the remaining key screw. The local circuit runs from one pole of the local battery to the register or sounder screw terminal, and from the other pole of the battery to one of the local binding screws of the relay; the circuit is completed by connecting the other relay local screw to the other register or sounder post.

In setting up telephone sets for exchange subscribers, there is really very little to do, beyond screwing up the instruments to the wall, because the inter-connecting wires between the different portions of the apparatus are all run in the shop. There is consequently nothing to do but to connect the in and out, or line and ground wires at the top of the set, connect the battery wires (which are all run) to the battery in the box below, and fasten up the transmitter and receiver in their appointed places. It must be remembered that in either class of installation, the lightning arrester is of no avail, until the ground wire is connected. No time should therefore be lost in attaching it.

(*To be continued.*)

TELEGRAPHING BY CIPHERS.

Last Tuesday the countenance of the operator in charge of a branch office of the Western Union Telegraph Company, located on Broadway, above Canal street, indicated amazement tinctured with disgust as he surveyed a message held at arm's length. The message was written on one of the company's ordinary blanks and read:

To John Chalfant, Tufft's Elephant Corral, Salt Lake City, Utah:
Xabggortza, lzqboptxag, cxmrtzulyo, grmltpaait, lopxxyzabx, racgkpmolb, oozkmrabty, cqmtgdbalm, hiayrtolbc, golzqbagg.

In the corner was written, "Paid $1." That was its unfortunate feature, for it was not the alphabetic jumble of the message that excited the operator's disgust, but a note from the main office pinned to the disguised despatch. The note stated that the operator had been charged $7.30 for the message, and warned him to be careful in future about accepting cipher despatches at a lower rate than that of a full word for each letter.

"I thought ten letters constituted a word, no matter how they were placed; but I'll know better hereafter," sorrowfully remarked the operator, and then added: "The next man that comes in here with a lot of sausage-meat English will hear from me."

The rate to Salt Lake City is $1 for the first ten words, and seven cents per word in excess of that number.

"No, we do not accept ten letters for a word, no matter how they are placed," said an official at the company's main office. "We have had to stop that and charge for the letters in cipher despatches at word rates. This cipher business is troublesome to the operator and makes slow work. Besides that, mistakes are possible. We take cipher messages now at rates as stated, but we do not hold ourselves responsible for their correct transmission."

"How about 'code' words?"

"Any word to be found in Webster's goes at regular rates, whether in a message that reads so that it is understood or otherwise. We only discriminate against the cipher."

"Is much telegraphing done by secret methods?"

"Lots of it. Merchants do it to reduce expenses, and others, from school girls up to the big market manipulators, do a great amount of secret telegraphing."

The use of code systems is greatly on the increase. Some make up their own, but the majority of business men have systems specially printed for them, or make them up out of the cipher books, which are to be had of all commercial stationers.

Mr. E. Parke Coby, the Adjutant of the Veteran Corps of the Forty-seventh Regiment, when asked about cipher systems took the questioner to the fourth story of a printing establishment, where a thin, dark little man, with intensely black eyes, was found cutting three dictionaries to pieces with a huge pair of shears. The dictionaries were in English, Spanish, and German, and the little man cut long strips of words from them, which he pasted on paper, and then drew lead pencil lines from the words to written sentences.

"He is connected with a South American steamship company, and is preparing copy for a cipher system for his line," explained the printer. "We will not print more than half a dozen of the books, but the cost will be over $200. After we strike off the required number of copies we destroy the forms, and do not even keep a sample for ourselves. You see the companies guard their secret ciphers as a man guards the apple of his eye. It would never do to let rivals or interested speculators get hold of their codes, or the company would often be forestalled in the market. We do considerable cipher work for exporters and importers, and men in the iron and foreign trade, as well as for steamship companies, but we never allow the work, when off the press, to be seen by any one except its owners. Cipher systems are coming greatly into vogue with the business men of New York. There is a great saving of expense in the use of the wires and less chance of misinterpretation and mistakes than when sending fully written despatches. Some customers are very secretive about their systems, and others do not appear to care anything for concealment. We get up a cipher system on an interchangeable plan by which not even the printer of the book can know the meaning of the code words."

"What is the expense?"

"Cipher systems, or codes, as they are called, when they are made to order, cost from $50 up. Some run as high as $400, and even more when very extensive. We make a novelty in book form consisting of a system which becomes

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secretive by the selection of a number. Such are sold at stores, and can be used by anybody."

At the office of Hatch & Foote, the bankers, a small cipher book was exhibited to the reporter. It contained names of stocks, with orders to buy or sell, quantities, advice, &c., all to be represented by a word or two.

"There is nothing secretive about it," said Mr. Emmerson. "We give the books to our customers. It is a saving of money in telegraphing, and an easier and more certain way of communication. We have no need of a secretive system in our general business, though the large operators use private codes."

This was on inquiry found to be the case; but any attempt to get a view of the private codes was regarded as the trick of a stock sharp.

Cashier Quinlan, of the Chemical bank, pointed to a pile of books on his desk, and remarked that they were the cipher systems of various corresponding banks, and that much of the business communicatian between banks is being done by cipher. Banks generally get up a separate system for each bank with which they deal extensively. The cipher books are carefully guarded in the bank's vault, and even then code orders are verified back and forth by other code words, systematized for the purpose, before a transaction involving much money is consummated.

Some houses having foreign connections and the steamship companies use very elaborate and extensive cipher systems. In such systems, over a cipher word column, it may read: "Can you secure —— bundles of hides and find room for the same on the next steamer? If so, telegraph us rates and particulars." At one side of the column of cipher words will be found a column of figures running from one up into the thousands. The figures indicate the number of bundles or quantity, and the entire expression quoted above, together with the number of bundles referred to, may read simply "Bones." If the message "Bones" is sent from New York city to Melbourne, Australia, by the way of the eastern route, it will cost $3, 40 cents being charged per word by the Atlantic cables, and $2.60 per word by the eastern or India lines. Written out in full the original twenty-four words would cost $72.

The Atlantic cables are more liberal in their treatment of ciphers than the land companies. The cables confine a word to ten letters generally, but accept of three cipher letters, whether they make sense or otherwise, for a word. That is, rxy or zbq pass as a single word. Three figures also count as a word; but when figures and letters are mixed, as, for instance, 6 qk or g 5 m, eaeh letter and figure is charged for as a distinct word. This is done to prevent too great a liberty being taken with cable despatches. Nearly all civilized nations, including China and Japan and the nations of South America, permit messages to be sent and received in cipher. Russia and her dependencies are the exceptions. Telegrams to and from Russia, Bosnia, Bulgaria, Servia, Roumania, Montenegro, Herzegovina, and Siberian points must be in open language, that the censors of the wires may read and investigate them at their leisure.

The most expensive all-wire message sent from New York city is one to some of the interior South American towns. They cost by direct cable and by the way of the Eastern $8.20 per word. To go by the coast lines and cables saves considerable on this rate, but when these lines are out of order the message has to take a transatlantic trip. But a message can be sent to distant Bosnia or Servia for only 52 cents per word, 40 cents of which is claimed by the cable companies. To reach Japan costs about $2.70 per word, and China the same amount. Khartoum can be reached at 95 cents, Turkey at $1 via Malta, or 54 cents via France. Messages to the various South American countries run from $1.40 to $3. Siam can be reached for $2.30 per word, and St. Petersburg for 58 cents.

In view of the figures given it will be easily understood why the commercial world takes kindly to cipher systems. —*N. Y. Sun*, Sept. 20.

QUESTIONS AND ANSWERS.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

[70.]—Calibration of Tangent Galvanometer.—"Tangent," of Amoskeag, N. H., inquires for the best method of calibrating a tangent galvanometer, and how to do it. Ans.—One of the best of the several methods is described by Carl Hering in THE ELECTRICIAN AND ELECTRICAL ENGINEER, January, 1885, page 7, as applied to a shunted galvanometer. A silver voltameter is preferable, however, in which case the electro-chemical equivalent of silver should be substituted for that of copper, as given in the formula, and the shunt eliminated altogether.

LITERATURE.

REVIEWS.

Electric B. and O., by J. G. PANGBORN. *Profusely Illustrated.* New York: Baltimore and Ohio Telegraph Co., 1885.

THIS beautiful *brochure* is one of the most elegant specimens of lithography which has been brought to our attention. It has been published for gratuitous circulation among the patrons of the Baltimore and Ohio company. The historical sketch of the Morse system of telegraphy is treated in a popular style, and brings to the attention of the reader the important influence of the Baltimore and Ohio Railroad Company in encouraging the development of this great invention. The introduction is a brief sentiment, penned by President D. H. Bates, in the form of a telegram to the author, "Competitive Telegraphy can be sustained. Electric B. and O. is a success." It is a fac-simile of an actual message in the neat and striking chirography of an "old-time" telegrapher, President Bates himself, and it would add much to the reputation of modern telegraphy if every communication was written by the receiving operator in such unmistakeable characters. The various accompaniments of practical telegraphy are graphically shown by the artist on every page. There is an occasional tinge of fiction grouped with the facts, and the streets of New York will be searched in vain for the original of the messenger who is depicted running at the height of his speed. Perhaps, however, this little work is intended to represent that high standard of perfection in telegraphing which is fondly looked forward to by those who realize its possibilities. It is a novelty in the field of electric literature, and those who secure one by the small investment of a postage stamp, will have reason to commend the excellent taste of its publishers, and the thorough workmanship of the American Bank Note Company, by whom it was designed, engraved, and printed.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Various Underground Notes.—The United States Company Starts Up its 29th Street Station.—The Fire Department Wires.—The Synchronous Multiplex on the Baltimore and Ohio.—The Elevated Railway Motor Experiments.—The United Lines Telegraph Co.

IT is generally supposed that the Commission on Electrical Subways, is obtaining a vast amount of valuable information from "inventors and others" who appear before it for the purpose of airing their schemes. As a matter of fact however, these gentlemen contradict each other to such an extent in their theories, that it is by no means an easy matter for the non-expert to decide between the false and the true. The Metropolitan Telephone and Telegraph Co. has submitted three large maps of its territory, one of which shows existing housetop lines, another the location of telephones in the city, the third, their proposed system of conduits, as well as the pole lines which they propose to retain. The latter form quite a formidable array, and are apparently sufficient in extent to excite the wrath of our metropolitan dailies, who will anxiously inquire why they also are not to go underground.

The United States Illuminating Co. made another unsuccess-

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ful attempt to obtain permission to transfer the poles and wires from 44th to 29th street, in order to make a connection with their new station at the foot of the latter on the East river. The Commissioner of Public Works made a personal appeal to the individual members of the commission to grant the permit on the ground that it was necessary in order that the company might carry out its lighting contracts with the city. The request was peremptorily refused, whereupon the company substituted business methods for diplomacy, and obtained a right of way over an existing telegraph pole line through 33d street to First avenue, and succeeded in reaching 29th street station with 15 wires. The machinery is now in operation, and death still remains in the air on the east side of the city.

Permission has been granted to the Fire Department to place its wires underground from Fire Hall on Mercer street, to such a distance as will permit them to be carried as a trunk system, at the end of which they will branch out in various directions both underground and overhead. A Broadway circuit will be furnished by the Western Union company in its tube to 23d street. For its own system the fire department will use the Waring cable.

A new building for the fire department is in process of construction at 67th street, to which the central office of the fire alarm telegraph will be removed. It will occupy the upper story, and the additional room secured will permit the introduction of several contemplated improvements in this already superior service. It is not decided as yet whether a duplicate set of apparatus will be constructed, or the present instruments transferred. The original cost of these was $25,000. The number of boxes in the city has nearly reached the limit of signals represented by three figures.

The Baltimore and Ohio Telegraph Co. is making practical tests of the Delany synchronous multiplex system, between this city and Philadelphia. It is working very satisfactorily, yielding six working circuits over one wire, upon each of which business may be transmitted in either direction. The distance between these two cities being comparatively short, and the telegraph business very large, the territory is peculiarly well adapted for the introduction of multiplex apparatus. Additional facilities for electrical communication will also be furnished soon by the American Telephone and Telegraph Co., which is making ready a fine pole line equipped with copper wire, preparatory to the introduction of long distance telephony on an extensive scale.

The Daft motor on the Ninth avenue elevated line made a few experimental trips several days ago, but the conducting rails are again covered with rust, and quiet reigns at present. The Edison people are working away at the Second avenue motor, and if all will exercise patience, the various electrical companies interested in the subject will eventually succeed in eliminating the "bugs" which apparently crop out as the work progresses. The Van de Poele people who have representatives at Elizabeth, N. J., are watching the results of these experiments with considerable interest, in consequence of the success of their motor at Toronto. None of the rival parties exhibit any desire to see their competitors encounter failure believing that such a result would have a dampening effect on the whole business.

The signs of the United Lines Telegraph Co. have been substituted for those of the Bankers and Merchants' at the various offices in the city. There is now every indication of an active competition under the new management, which is apparently being backed by strong parties who enter the contest with the usual enthusiasm.

NEW YORK, September 28, 1885.

CHICAGO.

The Van De Poele Electric Railway at Toronto.—An Experimental Telpherage System at Chicago.—The Ohio Tornadoes.—Selling Lottery Tickets Under an Electrical Alias.—The New Telephone Suit.

FROM Toronto, Canada, comes the most perfect realization up to date of the electric railway principle, and it is a matter of just pride here that the inventor, who is also the constructor, is a Chicago party. A year ago an experimental essay was made upon the same ground, with excellent results; but with that experience Mr. Van De Poele has been enabled to farther perfect his apparatus, until now success is achieved practically, as well as theoretically. The road in question is within the grounds of the exposition at Toronto, and connects with the street car line outside the inclosure. It was at first thought by the street line people that the motor line would be a failure, and with a dog-in-the-manger policy, they refused to lay the needed track inside the grounds. No sooner was there evidence of vitality and commercial value in the electric railway than an injunction was asked to prevent its being run. Fortunately, the line being entirely within the grounds, which were first conceded to the city by the government, and by the city to the exposition managers, there was no authority for granting an injunction on what was shown to be private property.

The entire length of road operated is one mile. The generator is a 40 h.p. dynamo of the Van De Poele pattern, run by a Doty & Son's engine. The wire leading from this to the rail is a No. 4 copper, the other wire being suspended over the track. Connection between this conductor and the motor is made by a deeply grooved pulley which presses perpendicularly upward beneath the wire. At each pole, of which there are 55, the suspension is flexible, so that the pulley readily passes, and by a variable lateral motion in the pulley any inequality in that plane is compensated for.

The motor is a 30 h.p. machine, weighing about 2,000 pounds. The current used varies between 5 and 18 ampères and 1,000 volts.

The grade of the road for about 2,000 feet averages one in twenty, and one or more of the curves, 250 feet radius. Mr. Van De Poele claims that the loss by conversion of power from the engine to the motor is but about 25 per cent., which is far less than half the machine shops in the country lose by their shafting.

The practical part of the story is found in the fact that this little road is doing regular daily work, 14 hours per day, six days in a week, and carrying during the busy portion of the day as high as 250 passengers per trip. On Saturday last, the 12th September, 6,000 tickets were sold, and that number of passengers carried. Of course an average of the passengers per trip for any one day would be no guide, for during the middle of the day there is but little travel, while in the morning the run is all one way, and the rush is in the opposite direction at night. The 6,000 passengers spoken of were carried during the hours between 8 A. M. and 10 P. M., the train making a trip every ten minutes. Owing to the sharp curves and the short track, high speed cannot be maintained.

If there is any other electric railway in the United States to-day which is earning its daily salt, will the promoters please rise and so state?

Mr. Van De Poele has a slightly different arrangement on exhibition here, the carrier being run upon two suspended cables. He has fitted up one of these on a vacant lot between Franklin and Market streets, the connecting wires leading into the back window of the factory. This form of railway is intended for transporting ore and the like along the levels of mines. In the model which traverses a track of about 500 feet, there is a steep artificial grade midway of the track, and it is quite interesting to watch the current measuring instrument as the car climbs the hill, passes the summit and runs down the decline on the farther side, with a scarcely perceptible variation in the rate of speed; yet the current gauge tells when the motor is using less or more power as faithfully as the steam pressure gauge tells its story of energy.

This experimental plant has completely proven, and the practical plant perfectly confirmed Mr. Van De Poele's theory that there is no loss of consequence in not insulating the wires for such purposes, where the current is not of too high potential. The Toronto plant ran equally well in a driving storm that thoroughly soaked everything and everybody exposed, as when all was dry and cold; and save the greater care necessary to keep from accidentally grounding the line by personal contact, and thus receiving unpleasant reminders of the diverted current, all seemed to work as well in one as in the other case.

Those were two very respectable tornadoes which swept through Ohio, on the evening of the 8th September.

That which coursed through the northern portion of the state, commenced as a wind storm near the west coast of Lake Michigan, coursing easterly, changed near Adrian to a tornado, cyclone or what not, and waltzed through sparsely settled districts nearly to Cleveland, where it re-resolved into a stiff blow, and died out. The second, far more destructive to life and property, started on its mission of destruction near the crossing of the Jeffersonville and Ohio and Mississippi railroad in Indiana, also eastward bound, doing its destroying and terrorizing principally near that point, at Cambridge City and Dublin, in Indiana, and the counties of Montgomery, Clark, Greene and Fayette, in Ohio.

The little town of Washington Court House, was nearly cleaned out, the path of the storm lying directly along the principal street of the place.

Capt. A. E. Goodrich, well-known to the general traveling public as the president of the line of lake steamers bearing his name, died on the 14th of September, aged 59 years. In addition to his position as above, Capt. G. was the proprietor and chief promoter of the Bain system of dynamos and lights, both arc and incandescent, and had recently erected a thoroughly comprehensive and complete establishment on the north side for the manufacture of the Bain apparatus. The business of the company will not be seriously disturbed by his demise, however, but continue as before. Capt. Goodrich leaves a son, his only child, about 19 years of age, who is now in Europe with friends from Chicago.

A reporter of one of our daily papers, possessed of more curiosity than credulity, recently investigated a business carried on in an obscure room hardly a fish-line's length from police headquarters. On the window was the legend "The Home Electric Appliance Company—Agents Wanted." Ostensibly for the sale of some magnetic humbug, water for frosting windows, and a fluid ink eraser, the real trade of the concern is selling tickets in the Havana lottery. Presumably the electrical application of

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the above legend to the lottery business lies in the positive surety of negative results to every one who is struck by that kind of lightning.

Well, the Bell patents are to have another struggle for existence. This time the question is a peculiar one, in that it is claimed that Bell surreptitiously obtained a knowledge of Gray's caveat claims, and changed his own claims to occupy the ground more completely, and so shut Gray out. This, so far, bears on its face an appearance of justice—the premises being granted—that the original inventor should have his just dues. But when we come to the codicil, so to speak, then this matter of injustice between Alexander Graham Bell on the one side and Elisha Gray on the other, is a matter of no consequence whatever. If neither Gray nor Bell invented the telephone, and Reis did, then of what consequence is this secondary clashing of the claims between Gray and Bell?

Frank Geraldy, in a recent article on the Pacinotti and Gramme rings, shows conclusively that the former was in reality the inventor, while the latter by another disposition of the apparatus, and more push and vim became known to the world as the originator of the ring principle in dynamos. The Pacinotti machine was perfect; ring, commutator, brushes, even to its reversibility, and was almost entirely unknown to the world, until the Electrical Exposition of 1881, where it received a diploma of honor. Pacinotti had the idea, and his machine practically expressed that idea; but he stopped at the laboratory model. Gramme, having arrived at the same theoretical point pushed ahead, rendered the machine practical, and gave to it a commercial value. He it was who gave the ring to the world.

To quote from Geraldy:

"For example—it is impossible to approach nearer to the speaking telephone than Reis did in his experiments in 1860; he constructed a telephone which would repeat musical tones, and it is also certain that it repeated some words; nevertheless Reis was not the inventor of the speaking telephone. It is true he produced the phenomena, but without doubt he considered the wonderful result as one of chance, and impossible of practical realization. He did not follow up the results he had obtained with a determination to succeed, conformably to a theory. Bell did—and Bell is the inventor."

Reis's invention had no practical value—and but for some subsequent worker in the field of vibratory law would have lapsed into disuse and oblivion like the phonograph.

The invention of Colt's repeater or revolver is quite popularly believed to be the original of that species of fire-arm. Yet in a chamber of the Tower of London, known as Queen Elizabeth's Armory, on the first floor of the White Tower, may be found the same revolving barrels which made Col. Colt famous, and a nine barreled Celtic revolver which did service in one of the old Irish rebellions, was at one time on exhibition in Buffalo. In both cases the turning of the barrel was accomplished by hand, but although these were known—at least were in existence—they would hardly have been considered by disinterested parties competent to throw the revolver patents, out of which so much money was made, into the public domain. The distance from that old Irish revolver to the first imperfect revolver of Col. Colt, or the Allen "pepper-box," was not nearly so far as that which separates the Reis and the Bell or the Gray telephone.

Somebody always has to eat the drumsticks and wings, and it is usually the fellow who doesn't push his ideas to a finality who gets left in the race; and the ruling is just, that he who gives to the world the advantages arising from his labors, whether mental or physical, is better entitled to protection than he who hides his light under a bushel, and watches for an opportunity to compel a division of profits earned by a more enterprising and industrious laborer in the same field, like the bald (white) headed eagle who never earns a dinner if he can help it, but prefers to rob the fish-hawk of his hard-earned quarry, when hunger presses. There are communists besides those who train round in the wake of brass-bands and red flags on Sunday afternoons.

CHICAGO, September 16, 1885.

BOSTON.

Agitation at the "Hub" over various Telephonic Matters.—Threatened Legislation in regard to Rates.—The Brown Telephone.—The New Time-ball.—Interlocking Signals on the Boston and Albany Railroad.—A Fragment of Morse Telegraphic History.

NEXT to the yacht race between the *Puritan* and *Genesta*, the telephone interests have occupied the minds of the people of Boston and New England quite extensively. First, we have the private lines in a tremor because the telephone company prefer to control the wires, which would seem to be a reasonable idea, as the telephones are not sold, but rented, and the company is blamed if the instruments do not work well; and as a business feature they should control the plant. Next, we have a universal growl because rates are raised. In Salem a dozen doctors agreed to order out their telephones if the rates were raised, and a great many people have come to the same conclusion. This is, of course, the natural protest against further expenditure of money by individuals. But the telephone people have really no other recourse; by next January $10,000,000 of their stock will be *interest* bearing, according to the agreements; money must be raised to satisfy stockholders, and telephones will be used. The telephone people know well that people who have used the telephone cannot get along without it. Threats are made of further legislation this winter; but that is three months in the future, and if the business boom *booms*, every one will feel so good-natured that forgetfulness will rule.

The financial columns of the daily papers have been discussing the present and future status of telephone stocks, particularly of the main company's stock. New England telephone stock at 29 is thought to be as cheap as American Bell at 192, as the latter will not be much of a success ten years hence unless New England is then a good deal more of a success than at present. Although American Bell is earning nearly 24 per cent. at the present time, so say these prophets, including the undivided earnings of its stocks in sub-companies, its present dividends are based upon telephone rentals, which, it is believed by the best telephone thought, must diminish gradually as telephone patents expire, until the treasury rests squarely upon its income from investments.

The statement is made that the American Bell has grown rich at the expense of the sub-companies, and taking in some $20,000,000 of the sub-companies' stock at the same time. To give permanent value to the American Bell the value of telephone exchanges must be increased. In the next five and ten years, it is thought, telephone rentals should go down and the American Bell should grow rich by the enhancement of the value of telephone exchanges. This is the problem now to be worked out. Concessions in telephone rentals are being made by the parent company, and the local companies are increasing their rates in the endeavor to do a profitable business.

The American Bell has enough to think of in defending its patents from the thousand and one assailants, and work out all the questions arising on every hand. Just at present we hear that "Mr. Brown" proposes to revolutionize telephony. This is probably a little one for a cent. [The full details of this instrument will be found on page 377.—EDITOR.]

The new time-ball, which has been greatly missed in our town for some months, will be ready for its daily dropping at the top of the post-office building in a few days.

More than a year ago the city of Boston voted an appropriation to erect a new ball, owing to the enforced removal of the old one from the Equitable building. This appropriation of a few hundred dollars was delivered to the Harvard College authorities having charge of the time service, as they had volunteered to erect the new ball. They delayed, however, until the Navy department instructed Lieutenant Marshall to do the work after the plans of the Naval Observatory, and drop the ball by Washington time. Harvard College is now erecting the ball with the city's appropriation, and will have charge of it, but will use the Naval Observatory's design. Harvard will, however, furnish the time. The new ball will be three feet in diameter, and, as it will be made of steel hoops covered with black canvas, it will be much lighter than the old copper ball. It will drop about twenty-five feet.

The Boston and Albany railroad desires to erect interlocking signals, at its own expense, at Westfield, Mass. The officers of the New Haven and Northampton road, which crosses the B. and A. at this point, at grade, think interlocking signals unnecessary and decline to join in their erection. They will be obliged, therefore, to stop all their trains before crossing, unless they subsequently agree in dividing the expense and using the signals in connection with the Boston and Albany. In the meantime they will be obliged to pay a sum equivalent to the wages of a signalman. A hearing before the railroad commissioners is to be had to settle matters.

I noticed a communication in a daily paper recently, relative to Prof. Morse's underground line, and as a matter of history recite it here. The article was signed by Leavitt Hunt. He says: "When Prof. Morse was engaged in the slow and tedious process of laying his first telegraph wire underground between Washington and Baltimore, a sudden shower compelled him to seek shelter under a bridge. While waiting there, he remarked to his son Charles (who told me of the incident) that 'when it was first proposed to use glass window panes in England it was strongly objected as impracticable on account of the risk of their being smashed. Glass was used,' continued the professor, 'and from here on I mean to string my wire on poles and take the risk.' And henceforth poles were used."

BOSTON, Sept. 21st, 1885.

PHILADELPHIA.

Opening of the Novelties Exhibition.—Free Lighting of the Building.—The Western Union to Change its Quarters.—Underground Privileges Granted.—Abandonment of the Fairmount Park Electric Railway.

ALTHOUGH chaos has not wholly abdicated its throne in the big frame building at the corner of Thirty-second and Market streets,

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the first celestial law is gradually re-asserting its supremacy. The "Novelties Exhibition" is now a fixed fact. The temple of the arts and sciences was formally opened to the public on the 15th instant.

At an early hour artisans and exhibitors were at work, busy as the oft-quoted bee, toiling against time, and trying to condense within a few hours the labors of a week. A very confused scene greeted the eyes of the visitors as their van came trooping in, filling the aisles, crowding the galleries, getting in the workmen's way, getting in each other's way, giving more attention to an empty space and wondering how it was to be filled up, than to the complete exhibit alongside of it, and finally coming to the conclusion that the only sensible way to see the whole show was to take things coolly.

Hon. Wm. D. Kelley was the orator of the day. He spoke of the benefits the institute had conferred upon the public by encouraging inventions, and of the mechanic's debt to it for the opportunities it had afforded him of enlarging his knowledge by studying and comparing his own with the ideas of other men. It had been largely instrumental, he remarked, in preparing the way for the Exposition of 1876, and was an institution that the people should never fail to appreciate and support. Each one of the novelties here displayed, said he, is valuable, inasmuch as it shows the wonderful range of man's inventive genius. Mr. Kelley then announced that the exhibition was open.

One of the features will be the varied illumination of the building. Professor Howe, of Norristown, the inventor of a system of water gas, is having constructed on the grounds an immense wooden tub of the capacity of 15 tons of water. It is part of his plant for making gas. He will supply light and heat to a part of the building and many of the exhibitors. Incandescent and arc electric lights of different companies and Siemens burners are arranged about the place. One electric light firm offered to light the whole building for nothing if all other firms could be excluded, but the offer was declined. As it is, none of those who supply the light and fuel will be paid a cent.

The quarters of the main office of the Western Union Telegraph Company, who occupy the basement and fifth floor of the New York Mutual Life Insurance Company's building at Tenth and Chestnut streets, owing to the constantly increasing business of the corporation, have proven very inadequate, and the managers determined, some time ago, not to renew the lease, which expires on the first of January next, but to secure more commodious quarters in a more central locality. The question of rent, the lease for the present office calling for $12,000 per annum, was another factor in determining the management in making a change of location, and steps were taken to secure either an entire building or quarters large enough to accommodate the business of the company. These efforts have terminated in the leasing for a term of years, from Mr. John F. Betz, the owner, of the old Tabernacle Presbyterian Church building, at the southeast corner of Broad and Merrick streets, at a rent of $7,000 per annum, and the work of improving the structure will be commenced as soon as the plans, which are now being prepared, are completed. It is stated that when the building is ready for occupancy the whole system will be removed to Broad and Merrick streets, and the Tenth and Chestnut streets office will be abandoned. This change will not affect the branch offices at Third and Chestnut streets and at other points throughout the city.

Among the first steps taken since the new location was selected was the introduction in Councils at the last meeting of an ordinance granting permission to the Western Union Telegraph Company to lay its wires underground on Market street, from Twenty-second to Fifteenth, to Chestnut, to Broad, to Merrick, to Front, to Walnut, and river front, and also on Third street, between Spruce and Vine streets. This afternoon a sub-committee of the Electrical Committee of Councils held a meeting for the purpose of considering the matter, and directed the ordinance to be reported with a favorable recommendation, provided the wires on Broad street, from Chestnut to Merrick, be laid underground, inside the curb line, so as not to break the asphalt pavement on Broad street, above Chestnut. Ordinances granting similar privileges to the Bell Telephone Company and the Philadelphia Local Telegraph Company, attached to which was the same proviso regarding Broad street, were also favorably acted on.

The scheme for an electric railway in Fairmount Park has been abandoned because the projectors concluded that with the conditions imposed by the park commission the road would not prove a profitable investment. As at first proposed the road was to run along Belmont avenue, from Elm avenue to Highland avenue, and the builders agreed to light Belmont avenue for the whole distance along their track. The permit was subsequently modified to avoid interference with the numerous drives that cross Belmont avenue, and the route prescribed for the road was from Belmont avenue, just north of the Ohio building, to George's Hill, while Belmont avenue was still to be lighted from Elm to Boundary avenues by the owners of the road. The distance that the road could run was so short, and the expense of lighting Belmont avenue with electric lights, when the track was not laid along it, was so great, that the builders addressed a communication to the park commission relinquishing the right granted them, and the plan has been definitely abandoned. The same gentlemen have arranged to make a trial of their system on the Ridge avenue railway.

PHILADELPHIA, September 19, 1885.

WASHINGTON.

The Underground Work of the Baltimore and Ohio.—The United States Electric Light Co. Putting Down Subterranean Cables.—Absorption of the Thomson-Houston System.—Competition for Lighting the Capitol.—The Western Union Underground Work Still Suspended.—No Indications as to Postal Telegraph Legislation.

UNDER the heavy pressure from the District authorities, another step in the direction of underground wires is being taken. The Baltimore and Ohio Telegraph Co. are now engaged in placing all their wires underground from the depot, where they enter the built up portion of the city, to their main office, Pennsylvania avenue and 14th street. They use the Averell system, by which some 80 or 100 naked copper wires are laid in a trench filled with peculiar asphalt concrete, by which, General Averell claims, each wire is kept from contact with the others or with the earth. By a process of his own he claims to avoid seams by making the work substantially seamless, or in other words, one compact mass, while it is expected to be sufficiently elastic to prevent cracking by the changes of temperature. An experimental section of considerable length was laid two or three years since in the outskirts of the city, where the conditions were such as to give it as nearly a practical test as possible, and it has fully sustained the expectation of the inventor. The insulation remains perfect. The present is therefore to be the first practical use of this system, and if expectations are realized, it will take a front place in the underground system, being economical and offering facilities for laying an unlimited number of wires, the expense per wire diminishing as the whole number of wires increase.

The United States Electric Light Co. is also engaged in laying a series of 12 single wire cables from their new station, near the capitol, to the more western part of the city. They use the Callender insulated cables, laying them in an ordinary pine trough, 12x5, of inch boards, which is thickly coated with tar to prevent its rapid decomposition. This company has secured the Thomson-Houston system, which had been to some extent introduced here, and was likely to prove a formidable rival. They now give their customers their choice of lights. They have rented the station formerly occupied by the Brush-Swan company, which, after expending some $23,000 in plant and experiments, suspended operations.

The United States company is now putting in new boilers, engines, dynamos, etc., and expect soon to be able to meet every demand for lights. In my next I hope to be able to give a full description of their additions to their original plant.

The lighting of the capitol building by electricity is likely to be the objective point with several of the different systems the coming winter. The pressure will be so strong that Congress will doubtless yield to some of them unless they succeed in killing off one another. The fearful defacement of the exterior of the building by the insects attracted in myriads by the powerful lights exhibited by the Brush-Swan company a year ago, has estopped any such brilliant illumination of the outside and surrounding grounds in the future

The injunction suit against the Western Union Telegraph Co., to restrain them from erecting an air line at the terminal of their proposed cable, is still in the courts, and the proverbial law's delay is likely to defer for a long time the result of the experiment with their pump-log conduit.

The present administration, so far as I can learn, has no defined views upon the subject of a postal telegraph. The subject may be mentioned as one of the matters worthy of the consideration of Congress in President Cleveland's annual message, but it is not likely to be urged upon that body.

WASHINGTON, D. C., Sept. 24, 1885.

ELECTRICAL NEWS AND NOTES.

THE NATIONAL TELEPHONE EXCHANGE ASSOCIATION.

SEVENTH ANNUAL MEETING.

Notwithstanding the predictions by many, that the 1885 meeting would not be of much importance, it was fully attended, and the legislation was of a character that evinced a determination on the part of the members to continue the useful work of the association

The meeting was called to order by President Morris F. Tyler at the Narragansett House, Providence, R. I., at 11 A. M., September 8th. Before proceeding to the transaction of business, the president introduced ex-Governor Henry Howard, president of the Providence Telephone Company, who cordially welcomed the delegates with a brief and appropriate address.

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He commenced by saying that, in behalf of the Providence Telephone Company, and voicing the sentiment of the community, he was sure, he extended a sincere and cordial welcome to the city and state. Remembering the character of the convention which was made up at Cincinnati two years ago, and recalling the impression made upon his mind as to the importance of the interests represented by you, and the intelligence displayed by those who were prominent in the convention at that time, he felt he ought to say more than a word of welcome. "I am not only glad to see you, but I feel," said the speaker, "that we owe you a debt of gratitude for taking note of our little state and accepting the invitation formally tendered to you by myself, and honoring us with your presence to-day. Words of welcome are oftimes a mere form, and I can hardly express how deeply I feel in greeting you. You represent a great and growing interest, and I am sure the entire community will be benefited by your discussions. While I cannot extend to you the freedom of the city, yet I know that you will be welcomed by the citizens at their homes and workshops. I hope you will carry away pleasurable recollections of the city. The Providence Telephone Company desire to extend to you the hospitalities of an excursion down what we are in the habit of calling our beautiful bay. We have arranged that the steamer Philadelphia shall be at your disposal at 1 P. M. Thursday next, for a sail of four hours, returning at 5 P. M. We hope that you will make your arrangements so as to omit your business on that day." The speaker hoped that the occasion would be agreeable, and that the members would have a safe return to their homes. [Applause.]

President Tyler briefly replied, saying that, as chairman of the convention, he felt justified in returning thanks to the Providence Telephone Company, through Governor Howard, for the invitation, and its acceptance of the same.

The first business in order was the calling of the roll of membership, active and honorary.

The American Telephone and Telegraph Company, of New York, was admitted to active membership, and the Callender Insulating and Waterproofing Company and Theodore M. Vail were admitted to honorary membership.

The secretary, W. D. Sargent, presented his report, from which it was learned that there were 41 members in active membership and 31 on the honorary list. The report of the treasurer was presented, from which it was found that there was a cash balance of $37.45, and outstanding bills amounting to $620.

The report of the Executive Committee was presented. The time for holding the session was fixed from 10:30 A. M. to 1 P. M., and from 3 to 5 P. M. It was also recommended that the secretary be paid a salary not to exceed $100 per month, and an assessment of $50 per member of the association, in place of $10, for the next year, to meet the necessary expenses.

President Tyler said that it had been decided that the secretary should be paid a salary, and to have a permanent office either in Boston or New York for the collection and distribution of statistics and matters of interest to the association. Action was deferred upon the recommendations until later in the session.

An invitation was read from the American Bell Company to visit Leicester, Mass., on Saturday, to look into the working of the village system in that place.

RETIRING ADDRESS BY PRESIDENT TYLER.

President Tyler said that the next business was the election of officers for next year, and he wished to decline a re-election, at the same time desiring to give a brief review of the history of the association, dating from September, 1880. He gave an interesting account of the first meeting, held at Niagara. "When we met there," said the president, "we were substantially strangers, and all in a state of enthusiastic uncertainty. He did not think any company could put their hands upon their books and say it had made a cent or expected to make a cent. The members were full of hope, but when analyzed it was exceedingly airy. In the spring of 1881 the conditions were different, matters having become crystallized and the opposition of the Western Union Company and Drawbaugh having been substantially withdrawn. In 1881-2 we were the most self-contented convention ever assembled in one room. All had made money and saw an indefinite expansion of business a long way off. In 1883 we were not so enthusiastic, and in 1884, at Philadelphia, were blue. We have been in periods of eager expectancy, in the flush of almost unexpected success, and now find steady, unremitting work, constant anxiety and careful forecast, not only for to-morrow, but for next year's business, as the result of an established concern with large interests to care for. We are burdened with the responsibility of large interests. Looking back over five years, we can point out many mistakes. It is of no use now to say that we made mistakes. It is of no use to say that we were too confident. It may now be seen, however, that the plan upon which the relations between licensee and licensor were established contained elements of weakness. It was the intention to treat everybody alike, when in fact they were not all alike. It had been forgotten that while one section was unlimited in growth, another might reach its limit. Mistakes have been made, but I do not propose any scheme by which they can be avoided. It is often more difficult to get out than to get in. We who are suffering vitally may think that by one stroke of the pen we may be relieved, but there is another side to the question. It is a problem at which both sides must work. One must be relieved without overburdening the other. We have reached the bottom of the curve and are beginning to climb."

In conclusion, he said that "in many respects the telephone business was dependent upon the general business of the country. He had seen what he believed to be an honest and permanent revival—not speculative. It is our business to keep our eyes open and profit by the experiences of the past, so that in a reasonable time we shall find ourselves on that delightful basis on which some licensees find themselves, where we can pay a dividend on all the stock after deducting both expenses and construction."

ELECTION OF OFFICERS.

The election of officers was then proceeded with, and resulted as follows:

President—C. N. Fay, of Chicago.

Vice-President—George F. Durant, of St. Louis.

Secretary—General C. H. Barney, of Jersey City.

Treasurer—H. L. Storke, of New York.

Advisory Committee—W. A. Jackson, of Detroit; B. E. Sunny, of Chicago; Morris F. Tyler, of New Haven.

Executive Committee—C. N. Fay, of Chicago; James Bigler, of Newburg; R. M. Bailey of Williamsport; C. F. Cutler, of New York; Henry Metzger, of Pittsburg.

Vice-President Durant was called to the chair in the absence of president-elect Fay, and made a brief acknowledgment of the honor.

Mr. Sargent then offered a motion that the association meet at St. Louis next year, the time being left to a committee, consisting of Messrs. Carson, Easterbrook and Metzger, to report at the afternoon session.

A STANDARD WIRE GAUGE.

Mr. W. D. Sargent, chairman of the committee on a standard wire gauge, read the following report:

Your committee on wire gauges received replies from the following parties:

1. Clark Insulated Wire Co., Bristol, Pa., favor the English standard gauge, and state that the present uncertainty in gauges is an embarrassment to their business.
2. W. A. Jackson, of Detroit, Mich., is in favor of a standard gauge, but has no preference.
3. C. N. Fay, of Chicago, favors the English gauge because we buy more or less wire in England.
4. Alfred F. Moore, of Philadelphia, favors the American gauge because all manufacturers of insulated wire use it.
5. E. T. Gilliland, of Boston, favors the micrometer screw and diameters in mils, or thousandths of an inch.
6. The Palmer Wire Co. are very much in favor of a standard gauge, but express no preference.
7. The Phosphor-Bronze Smelting Co., of Philadelphia, favor the English standard gauge, except in the finer sizes, and think if no standard is adopted that all gauges should be abandoned and the micrometer screw used to indicate sizes of the decimal part of an inch.
8. The Standard Electrical Works, of Cincinnati, desire to see a standard wire gauge established because they are constantly annoyed by orders for wire, but without specifying the individual gauge. Their preference is the American gauge.
9. Holmes, Booth & Haydens, of New York, are sensible of the importance of a standard gauge, and recommend the adoption of the English gauge, so that there will be a uniformity between the two countries.
10. The American Electrical Works, Providence, R. I., say that they are greatly annoyed in their business by the multiplicity of gauges. They favor the entire abolition of all gauges, and wires to be identified by their diameters in thousandths of an inch. In practice, they find that this plan works well in their particular business, and they claim to have abandoned the use of special gauges in the work of their factory, and their employés know the wire by its diameter in thousandths of an inch better than they know the gauge.
11. The Western Electric Company, of Chicago, believe that the American gauge and the English standard gauge are the only two to be considered. They prefer the English standard gauge, because we can never hope that the English will adopt ours, and it is a matter of considerable importance to have a uniform standard gauge wherever the English language is used.
12. Clark B. Hotchkiss, of New York, suggests either the English gauge or the American gauge, but with a preference for the English, because it is in use both in France and England.
13. D. H. Bates, president of the Baltimore and Ohio Telegraph Co., thinks the Birmingham gauge is the nearest to perfection of existing gauges, but is much interested in any movement looking toward the establishment of a uniform gauge. He thinks the numbers given with a given diameter should bear

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some definite relation to the measurements in mils, and wishes to know the result of our deliberations.

14. The Callender Insulating Co. believe that it is of the utmost importance that one uniform gauge should be adopted, and that it would be an immense advantage if it could be made international. They recommend the English gauge in preference to all others.

15. Washburn & Moen believe that the decimal or metric system of gauges would be the best to adopt. They were the first concern to use the " V " gauge in the world, and state they have found it convenient and reliable, and by its use have avoided much annoyance. They express no preference for any particular gauge, but believe that any that would be standardized would soon be generally adopted by manufacturers.

The Western Electric Co. supplement their first reply by the following memorandum from their agent in Antwerp: " You may not be aware that there is no ascertainable gauge in use by the English. The brass people, for example, do not know the gauge called 'B. W. G.' in your telegraph catalogue, and the only way to get what you want is to give the sizes in mils. So far, I have heard of no move among the English to adopt a new standard gauge, and until they adopt that I do not see that you are going to gain anything by abandoning the American gauge, which people now understand. The English gauge has been legalized by the Board of Trade, but this amounts to no more in practice than the legalization of the metric system in America. The metal people are all against the new gauge, and say it was made up by a set of people who knew nothing about the thing practically. Perhaps they say this because they were not consulted in the matter."

Mr. Barton, of the Western Electric Co., commenting on this memorandum, says: " The great difficulty about gauges at present is that there are no safe gauges in common use. The convenience of the public is not so much to get any new gauge adopted as to get all the gauges in use, except one, discontinued. The united association might now secure the almost universal adoption of the American gauge, while in my judgment the adoption of the English gauge would result only in adding one more to the number of gauges now in use. I have learned by discussing the matter with general drawers in the United States that they would much prefer to adhere to the American gauge."

Your committee have placed themselves in communication with all the parties interested. While we have no written or official reply from the Western Union Telegraph Co., we are inclined to believe that if this association would favor the adoption of the English gauge, they would coöperate with us.

The replies come from 15 different parties; seven favor the English, and two the American gauge; six have no preference.

The work of investigating the origin and development of the numerous gauges in various countries, analyzing and comparing their merits and discarding all the advantages without making too great a departure from the Birmingham wire gauge, which is the most generally used, is so thoroughly done by a committee of the British Society of Electrical Engineers, that the committee feel that they will honor themselves and gratify their English friends by accepting their conclusions, and recommending the English standard gauge as the one best adapted to the wants of this country, and in lieu of any arguments of their own in favor of this decision, we refer the members of the association to the report of the English Society, published in volume viii. of their proceedings.

Mr. W. H. Preece, a member of this committee, has very kindly furnished your committee with the " Instructions and Orders of the British Board of Trade," legalizing and making this the standard gauge of Great Britain. He also furnished a number of copies of the gauge, which we submit to the inspection of members.

The committee desire to express their thanks to Mr. Preece for his courtesy in furnishing them with all the information on the subject, as far as the British government was concerned.

W. D. Sargent,
D. I. Carson,
T. B. Doolittle.

In order to bring the subject properly before the meeting, a motion was made that the new English standard gauge be adopted.

Mr. C. B. Hotchkiss said that not only had the English government adopted metrical measurement, but that Germany, France and England were now using the improved English gauge.

Mr. Sargent stated that he had endeavored to confer with the Western Union authorities upon the subject. He would favor the improved gauge, which was simply the old Birmingham gauge standardized, and was practically and scientifically as perfect as the American gauge.

Mr. Lockwood expressed himself very strongly in favor of the new English gauge. It was certainly equal in merit to any other, and he concurred in the belief that as it could never be hoped that England would adopt our gauge, it would be best to adopt the English gauge. Any standard was preferable to the present lamentable need of one, or the multiplicity of gauges not generally recognized. He looked forward to the time when customers will order wire not only of a certain diameter in mils, but of a specific resistance and weight per mile.

Mr. Chester Wilson said that a great many efforts had been made to bring into use a uniform gauge, not so much for the sake of endorsing any particular gauge, but in order to secure a recognized standard of some kind.

Mr. Callender suggested that the association confer with the electric light people before adopting a standard.

Mr. Lockwood expressed himself as decidedly opposed to any such action. The electric light people, in their convention at Chicago, and elsewhere, had expressed such thorough indifference to telephone interests, that he had no desire to compliment them to that extent.

The mid-day recess was then taken.

Upon reassembling at 3 P. M., Mr. T. B. Doolittle, a member of the committee on standard wire gauge, addressed the meeting, saying that he differed with the majority of the committee on this subject. He objected to the adoption of the English gauge, for it would add confusion to the present system of gauges. We have a gauge in general use—the Brown and Sharpe—which is employed by all manufacturers of brass and copper wire, a gauge that is understood thoroughly by the trade, and possesses all the features necessary to a first-class wire gauge.

Mr. Doolittle here presented a diagram illustrating the above statements. The Brown and Sharpe gauge is in common use among the manufacturers of copper and brass wire. If we could take that gauge now and extend it to the field of iron wire, every one would understand it, and there would be no confusion. It would require a generation of time before we could successfully get the English standard introduced. In England now it is only in theoretical use. We have a substantial system of gauging wire, and there is no necessity of changing it.

Mr. Hotchkiss, of New York, reiterated what he said in the morning in regard to the adoption of the English standard gauge. The question of the diameter of the wire and the weight of it is what we must arrive at, and the best results can be derived from the gauge in universal use outside of this country.

Mr. Sise, of Montreal, alluded to the fact that the German government used the English gauge exclusively, Germany and England furnishing practically all of the wire in use on the continent, and the only gauge is the English standard gauge.

Mr. Shippy, of New York, said he thought it was not very important what gauge was adopted. He would suggest the adoption of any gauge, so that it be understood by manufacturers.

Mr. Sargent said that the very confusion that had been alluded to arose from the fact that there had been no standard gauge. The largest manufacturers of wire are in England, and they have adopted this gauge, which is an improvement on the Birmingham gauge, which is in the widest use. It is not well to disregard this because we may have a sentimental feeling prompting us to use the other. We want a gauge which shall be universal.

Mr. Doolittle said that what they wanted to do was to avoid confusion. They had been a quarter of a century trying to perfect their system, and now to attempt to introduce another gauge would be to introduce confusion.

Mr. Barton, of Chicago, maintained that the attempt to adopt a single wire gauge for this generation would not meet with much success. The wire gaugers for sheet and brass use the Brown and Sharpe gauge. They are used to it, and it would be a great job to get them to discontinue it. Then, why adopt the English standard? It is only adopted abroad in theory. If there were only two gauges to be decided upon, the best thing would be to adopt the English gauge, which has some advantages over the American gauge. In this country it could never be used. The Brown and Sharpe gauge is largely used already, and will continue for a good many years. By introducing the English gauge we shall only be working for posterity and not for ourselves. If we undertake to introduce a new gauge, I would like to see a movement to concentrate on the Brown and Sharpe gauge. No matter, however, what gauge is introduced, we shall have to fall back on the relation of thousandths of an inch. All of our manufacturers would draw wire according to the thousandths of an inch.

Mr. Lockwood, of Boston, said that no matter what gauge is adopted, it is probable that corporations ordering wire would say in thousandths of an inch what they wanted ; that when the gauge is not specified the old gauge is understood. He had no doubt as to the propriety of endorsing the views of the European countries in this matter.

Mr. Eckert, of New York, said that he did not believe there were six gentlemen present who could tell the difference between the gauges.

The chairman said that he would like to cast the weight of the association in favor of a uniform gauge throughout the world. This uniformity is creeping into commerce as well as in mathematics, and this association ought not to delay action looking towards a uniform standard gauge.

Mr. Durant said that if all associations could be bound by the action of this association, the passage of the resolution would do

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some good, but he could not see at present that it would amount to much.

Mr. Metzger said that he could not see what good the resolution would accomplish, unless we made a standard by law. What we want is something by which if a dispute arises between the buyer and seller there shall be a regular standard which shall decide the controversy.

Mr. Wilson, of Philadelphia, said that so long as we adopt the American gauge, we have two in the world. We cannot hope to do away with all but the American; but by recognizing the English standard gauge, we are working in the direction of one uniform gauge and not two. If this telephone association adds its strength by this recognition of the English standard, one step will be taken towards the adoption of a universal gauge. He hoped the vote would be strong in favor of the English standard wire gauge, which would be an independent movement towards actual uniformity.

The resolution was then put to the meeting, and passed with only a few dissenting votes.

The resolution was as follows:

Resolved, That the members of this association, so far as they can, will adopt the English standard gauge for their future work.

In accordance with suggestions made by a number of the members, the secretary was instructed to furnish to the members in circular form a complete statement of the new standard gauge, including a statement of weights per mile of iron and copper, and the resistance per mile of each number of gauge; and also notify the electrical societies and manufacturers of the adoption of the standard gauge, and express the hope that they will follow their example.

The next business in order was the consideration of the recommendations in the report of the executive committee, presented at the morning session.

The first recommendation suggested the levy of an assessment of $40 upon the members to meet the expenses of the current year.

The second recommendation was in the nature of an amendment to the constitution, so that the annual dues shall be $50, instead of $10, which was laid over until the next meeting, under the rules.

The third recommendation was to the effect that it was deemed advisable to employ a secretary at a salary not to exceed $100 per month. The recommendation was approved.

The fourth recommendation contemplated an amendment to the constitution, providing that a paid secretary shall be appointed by the newly elected executive committee, rather than by the association as formerly. The matter was laid over under the rules.

Mr. Storke offered an amendment to the by-laws, enlarging the duties of the secretary in the compilation of reports and statistics presented by the several committees, under the direction of the executive committee. The matter was laid over under the rules.

An invitation was read from the Pawtucket Thread Co. to the association to visit the works, and the invitation was accepted with thanks.

At 5 o'clock an adjournment was taken to Wednesday morning at 10.30 o'clock.

WEDNESDAY, SEPTEMBER 9.

The association assembled at 10.30 o'clock, president C. N. Fay in the chair.

Mr. Carson, from the committee on time and place of the next annual meeting, presented a unanimous report recommending that St. Louis be the place, and the first Tuesday in September as the time. The report was adopted.

Mr. Hall, of New York city, gave notice of an amendment to the constitution. He had found that there were 41 active and 31 honorary members, showing that the membership was nearly equally balanced. His amendment contemplated the establishment of regular and associate, the latter not being directly concerned in telephonic occupation. His amendment to article 2, section 1, is to the effect that any honorary member may be elected by a two-thirds vote of all the members present at any one meeting, such election to be by ballot. He also presented a new article, to the effect that any person or corporation actively interested in the objects of the association, may become an associate member by a majority vote of the members present. Section 2 provides that associate members shall have no vote, but shall be entitled to all other privileges of regular members, and be subject to the same dues and assessments.

The amendments were laid on the table for consideration at the next meeting.

Mr. Lockwood proposed the name of George L. Wiley, of New York, for honorary membership, and he was unanimously elected.

LONG DISTANCE TELEPHONING.

The first paper was prepared by Mr. A. S. Hibbard, of the Wisconsin Telephone Co., and was read by ex-secretary W. D. Sargent, of Brooklyn, N. Y. The subject was, "Some Practical Results of Long Distance Telephoning," and gave an interesting statement of the results obtained by prominent companies in this country and abroad. Mr. Hibbard stated that it was thought that in 1877 the first successful long line results were obtained in experimental tests over telegraph lines. In 1874 many short telegraph lines were equipped with telephones as private lines, and as such were used between stations five to fifty miles apart. In 1878 and 1879 the extension of extra territorial lines, or toll lines, was begun, and the "bean pole" and "barn top" lines were constructed, retarding in some instances the development of successful long line systems. To-day the well-known results of six years' work are exhibited in a showing of 1,252 exchanges, 134,847 subscribers, 539,388 exchange connections daily; 25,766 miles of poles in toll line, 35,631 miles of wire; 18,330 toll connections daily. Mr. Hibbard then gave such figures based upon the statements given by several prominent companies, with exchange lines. The rates were generally uniform, the minimum being 25 cents and maximum of 50 cents for use of a wire five minutes or less. The paper considered the toll ticket plan as profitable, and then devoted considerable space to the matter of interrupting noises. The introduction of resistance into the circuit has been found beneficial in suppressing inductive disturbances, but has in a corresponding degree weakened the telephonic effect. Leaky lines have been found less noisy than those well insulated. The most natural and general remedies are a louder transmitter and a less sensitive receiver. It has been proven beyond dispute that the best wire for long lines is that of the smallest diameter and of the lowest resistance. The hard drawn copper wire was perfected and introduced largely, and the best results in long distance telephoning have been obtained over this wire. In conclusion, the essayist stated that the inventive genius of the world is straining every nerve to produce the "far speaker," and no such pressure was ever brought to bear on any one department of business. For the solution of this problem the public looks to the American Bell Telephone Co. and its licensees in the United States. It is with much confidence that he ventured the opinion that the expectation will be satisfactorily and speedily realized. The Chicago company has a main line of 62 miles, and entire plant of 348 miles; the Wisconsin company has a main line plant of 110 miles, and entire plant of 335 miles; the Michigan company has a main line of 100 miles, and entire line of 190 miles; the Bell Telephone Co. has a main line of 85 miles, from Buffalo to Rochester. The limit of distance in practical and profitable working is about 100 miles, although a considerable business is done over 150 to 200 miles of wire.

In the discussion which ensued, and in response to inquiries as to the present limit of long distance telephony, Mr. Cowles, of Buffalo, stated that there was a line of 90 miles between Rochester and Buffalo, over which, at certain times during the day, conversation could be carried on fairly well. At that distance, however, such work does not constitute a good commercial line. They have no lines over 50 or 60 miles in length, which is about the limit of practical work.

Mr. Sise, of Montreal, said that his company had a main line 800 miles in length, and were working about 3,000 miles of trunk lines. They used No. 9 wire. They worked distances of 150 to 200 miles, the wires not being insulated.

Mr. Uline, of Albany, said that a copper wire from that city to Newburg, 100 miles, was perfectly satisfactory, the wire passing through two switchboards.

Mr. J. J. Fowler, of New Orleans, said the Great Southern company had a circuit of 138 miles, No. 14 copper, which was worked through two intervening exchanges, also 115 miles of No. 14 steel wires as feeders. There was also a line of 120 miles of No. 10 wire, working through three cables.

Mr. Sise did not think the cost of maintenance was of so much importance as that of accounts. At present about 25 cents worth of bookkeeping is required for each 25 cent message.

Mr. Fowler had thought it possible that the large expanse of water in his territory under the lines might have a beneficial effect upon their working.

Mr. McCluer, of Richmond, entertained a similar belief. They have a line to Point Pleasant which works well, while another between Richmond and Petersburg can scarcely be used on account of the disturbances arising from induction. The former line runs along the James river, while the other goes across country. Without presenting any theory, he suggested that veins of metalliferous deposits, or bodies of water running parallel with the wires, might furnish a channel for extraneous currents, thus relieving the wires from such influence.

Mr. Lockwood said that for the benefit of the association he was compiling a list of all the remedies which had been proposed for eradicating induction, which he hoped to present at some future meeting.

Col. Keller, of Boston, stated that their limit of long line work was practically 40 to 50 miles, although they had occasionally talked with Portland, a distance of 110 miles.

Mr. Sargent stated that no difficulty was experienced in working a copper wire between Jersey City and Trenton, 65 miles, but there is difficulty in working through the North river cable to New York, and consequently the wire was of no practical use, as there was but little business between Trenton and Jersey City.

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EXCHANGE STATISTICS.

B. E. Sunny, of Chicago, presented the annual paper. There are 42 exchanges of over 50,000 population, representing in round numbers 60,000 subscribers. Of that number 27 exchanges represented 40,000 subscribers. From the tabulated statement it is found that the Providence exchange has 2,162 subscribers, an increase of 270 over last year, a ratio of 1 to 48 in proportion to the inhabitants as per the United States census in 1880, 104,857. Brooklyn has the largest increase in subscribers over last year, 508; New York, second, 444; Chicago, third, 404. Ten exchanges reporting this year and last, and having, in 1884, 18,408 subscribers, have 20,408 in 1885, an increase of 2,000, or 11 per cent. Ten exchanges reporting in 1884 and 1885, in 1884 handled 108,631 connections daily, and in 1885, 136,086, an increase of 25 per cent. in one year. New York has increased 15,000 a day; Brooklyn, 5,000, or double that of last year; Cleveland, 6,000, notwithstanding the increase of only three subscribers; and Chicago, 4,000. On the other hand, Philadelphia, with an increase of 111 subscribers, falls off 4,000, and Albany and Denver show a slight falling off. Providence had 12,046 daily connections. Detroit has 10.6 calls daily per subscriber, Cleveland 10, Chicago 8, New York 7. Providence has 5.2, against 5 in 1884. The offices working on the multiple system, eight in number, average 387 connections per operator. The remaining nine, not multiple, average 268 connections per operator. Albany, Cincinnati and Denver are making less connections per operator than a year ago. Detroit leads with 710; Pittsburg second, 526; Baltimore third, 390. Providence has 335. Eight multiple boards average73 subscribers wires per operator. Nine boards, not multiple, 50 wires per operator. Washington has 126, Milwaukee 91, Brooklyn and Detroit 71 wires each, while Providence has 71 wires per operator. The cost of connections has been materially cut down since a year ago. New York shows the fastest time on record in 10 connections on the Law board, being 2:20—as fast time as Boston on the regular board. Cincinnati is at the bottom of the list, with 23 minutes, and Providence is 14 minutes, or 7 minutes slower than last year. The number of trunk lines is increasing rapidly, nine offices having increased from 1,393 to 1,712, or 23 per cent. Providence alone shows a decrease, being 37, or 5 less than in 1884, 1 less than in 1883, and 11 less than in 1882. Fifteen exchanges, representing 31,955 subscribers, have 491 instrument troubles daily. The average use is 12 times daily. Each telephone, it is estimated, is used 780 times before becoming defective, which may be regarded as a good showing. The report suggested a more universal adoption of the galvanometer for the purpose of discovering defects in lines and instruments that are alike hurtful to city and toll line service. The Chicago company found 112 defective wires, and removed 100,111 ohms resistance, or an equivalent to the resistance of 3,128 miles of No. 12 iron wire. The galvanometer easily detected these obstructions.

The paper was received, placed on file, and a vote of thanks tendered to Mr. Sunny.

LEGISLATION.

An interesting and instructive paper on "Legislation" was read by the treasurer, H. L. Storke, in which he reviewed the legislative proceedings with reference to telephonic interests throughout the country, in an able and comprehensive manner.

Mr. Lockwood, of Boston, in commenting upon the paper, spoke of the necessity of concerted action on the part of the association to defend itself from antagonistic and mischievous legislation.

President Fay also referred to the efforts of the enemies of telephone associations to influence legislation. He claimed that it was generally the gratuitous work of persons who had axes to grind, who expect to be bought off or are hopeful of gaining popularity. They are persons who resort to underhanded measures, and fear to meet open and fair argument. President Fay hoped that the members of the association resident in the several states would keep the secretary fully informed of legislative proceedings for mutual profit and protection, and the secretary would circulate such information among the members from time to time. The association should oppose a united front and seek to protect their interests by the most efficient representation at the state capitals.

Mr. W. H. Eckert gave a summary of the underground work which had been accomplished in New York city. The systems introduced by the Metropolitan company are the Brooks, the Western Electric, and the Edison. From the 39th street exchange the Patterson cables were used, of 50 and 100 wires. The longest was 1,939 feet, and the shortest 1,300. These cables contained 868 conductors, of which 629 are in use. They are placed in a wooden conduit, three feet below the surface. At the 21st street exchange the Edison system was used, with from 100 to 700 conductors in each cable, each wire insulated and then bunched together. The pipe was in 30-foot sections, four feet underground, and covered with boards.

At the Spring street exchange the Brooks system had been introduced, comprising two 4-inch pipes, each containing 380 wires. Out of 760 wires, 501 are in use. The longest pipe is 2,448, the shortest 365 feet. They are placed three feet underground, the cable drawn in and the pipes filled with oil.

There are 614 miles of wire in all three systems, and they are working satisfactorily.

Invitations were received and accepted from the Providence Telephone and Brown and Sharpe manufacturing companies to visit their respective establishments.

The meeting then adjourned until 3 o'clock.

Upon resuming business an invitation was received from the Washburn & Moen Manufacturing Co. for the association to visit and inspect the works of the company at Worcester at such hour on Saturday as convenient. The thanks of the association were voted the company.

THE UNDERGROUND PROBLEM.

The first paper of the afternoon was read by Mr. W. R. Patterson, of the Western Electric Co.; subject, "The Underground Problem." The paper was in substance as follows:

There are two classes who do not admit the existence of the "underground problem," namely, the enthusiastic inventors and promoters of "systems" and the average state and city legislator. The two form a mutual admiration society of gentlemen of vast scientific attainments and disinterested philanthropists. One of the former will admit that it used to be a problem over which electricians had labored in vain: the subject was accidentally brought to his attention by a newspaper report of the delay to the firemen caused by a lot of wires. It immediately occurred to him that those wires might be put underground. He lays no claim to any electrical knowledge, but is only a man of marked practical common sense, unhampered by any scientific hair-spliting. Governed only by the practical common sense requirements of the case, he devoted several hours to thinking on the subject, and the problem was solved. Not satisfied with its general solution, he subsequently went through a long course of mental experiment, thoroughly reduced it to paper, and had it patented. It now only awaits your adoption. The promoter of the Universal Electric, Signal, Telegraph, Telephone, Electric Light and Power Transmission, Underground Insulated Cable, and Conduit Construction Co., knows the system can only be an unqualified success. Isn't it patented? If that isn't enough, didn't the attorney tell the inventor that an examiner in the office overheard the commissioner say to the secretary of the interior that there wasn't anything in the earth or the heavens above, or the waters under the earth, that in any way resembled this wonderful invention?

Some rainy day when the base ball game is postponed, the leading newspaper sends its scientific reporter to find out all about the subject. The reporter is a young man just out of a college where he has learned all about the recession of Greek accents; he laughs scornfully at the man who asks him how they make those little telephone wires hollow, and the next day furtively picks up a piece to examine, finds it solid, and thinks he may have been mistaken, after all, and got a piece of telegraph wire! This knowledge, backed by a vivid imagination, and all the information obtainable from the inventor, furnishes the basis of a long local article and of an editorial in which is duly set forth the meanness, heartlessness and want of regard for the rights, property and lives of our citizens on the part of these grinding monopolies. The philanthropic legislator is impressed by all these things. He "don't take no stock in them scientific chaps; they are all in the pay of some big monopoly, and everyday hoss sense is good enough for him." He knows of no obstacle, mental, physical or moral, that money will not overcome, and here is a chance to get at these "grinding monopolies," help the struggling inventor, make business good, and get the vote of that man who is kicking about a telegraph pole in front of his house. So an ordinance is passed requiring all the wires to be placed underground within thirty days, and what is the use for us at this late day to talk about an underground problem?

You, gentlemen, have all read the information furnished by such a reporter, have suffered under such a legislator, and been taught your business by such an inventor. It has been demonstrated to you beyond question that your wires will work better and for a longer distance, and that there can never, under any possibility, be any outlay for repairs or reconstruction in this underground system. If you have not already, it is probable that you soon will meet with a sufficiently enthusiastic promoter who will demonstrate mathematically that the junk value of your old wire and insulators, and the kindling wood value of your poles and fixtures, will pay for an entire and absolutely perfect underground system. Yet in spite of all these demonstrations, and in spite of the assumed power of a city council to regulate not only the laws of trade, but the laws of nature, it is a fact that men who are practically interested in the matter still see difficulties in the way.

These difficulties may be divided into three general classes—scientific, mechanical and financial. One man tells us there are no scientific difficulties in the way of underground telephony, and another tells us they are insuperable, and both are right. If it is only a question of talking across the street, there are none; if it is a question of talking across the ocean or a continent, they

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are insuperable with our present knowledge. It would be very rash to claim they must always be so, but it will take something besides an act of the legislature, or an ordinance of the city council, to overcome them. The scientific obstacles in the way of unlimited and universal underground telegraphy and telephony are retardation, escape and induction. These difficulties are common to underground wires for all uses, but are especially troublesome in telephone work. It is the subject which has received least attention from inventors of systems, and it seems entirely beyond the comprehension of most people that an underground wire, say from the Harlem river to Jersey City or South Brooklyn, may, in some respects, be an exact counterpart of an aerial line from New York to Buffalo or Pittsburg.

The causes of retardation are well understood, and its laws well defined, both by mathematical reasoning and by actual experiments upon long submarine cables. Every text book of electricity gives formulas for the speed of working cables, and in connection therewith the distance which a cable of any specifications can be worked at a given speed, which is the telephonic way of stating the case. If a telegraph cable will not work at the rate of 40 words per minute, it may be perfectly feasible to work it at a speed of 20, and it is only a question of providing a duplicate cable if the business requires 40 to be sent. But the laws of acoustics fix the number of vibrations per second for any definite sound, so if a cable cannot carry the requisite number, that is an end of the matter. The distance which can be marked is shown to be a function of the resistance of the conductor and its electro-static capacity. In the present state of metallurgical science it is not to be expected that a better conductor than copper can be found. While chemists and others, principally others, can turn out new insulating compounds almost without number, they can all be grouped into a few generic classes, the properties of which are well understood. It is not to be expected that a material of lower inductive capacity than air can be discovered, or an insulator suitable for underground use which even approximates the low capacity of air. We cannot make up the deficiency by increasing the thickness of the insulator indefinitely, because that has comparatively small effect. Besides these theoretical objections there are practical difficulties in handling a large number of wires which necessarily limit the size of each, and finally there is a limit to the last which precludes the use of metal and insulator in unlimited quantities per foot. The other factor, the resistance of a telephone circuit, has been generally, until of late, considered to be of little importance.

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After the mechanical work connected with the manufacture of the wire and its insulation is properly performed, there still remain mechanical difficulties to be overcome in laying the wires so as to secure the utmost possible durability, or even to insure any service at all. None of these mechanical obstacles are insuperable, or offer as much difficulty as the electrical requirements which we have discussed; yet they are not to be neglected, as any want of forethought or care in handling and protecting the wires may destroy the best electrical work. Most of the mechanical difficulties experienced are of such varying character that only a careful study of the conditions existing in each place can overcome them. In general, the system which requires the least possible work to be performed in the street will escape much of the danger of injury. The number of impossible things that happen and the grand aggregate of all the little things that are done to the detriment of the work by an inquisitive crowd, the weather and the total depravity of inanimate matter, would seem incredible to any one who had not experienced them. What is the best method of protecting underground wires from external injury, is as easy to decide as the best way of protecting human life from loss by accident and violence. The ideal protection for underground wires would be a dry, light, roomy and well ventilated subway. Such a one can be constructed with the utmost facility on paper. It would be found in a city built to order under one comprehensive plan, and before it is lived in completely equipped for 100,000 or 1,000,000 inhabitants, as the case might be, with no subsequent additions allowed. But we have to take cities as we find them, which, like Topsy, "have growed." With the existing systems or more generally lack of systems of sewers, water, steam and gas pipes, street railways, and the general plan of streets and alleys such a subway is impractical. We are reduced to two general methods of protection; one is to lay the wires or cables, and fill in around them with a mass of protecting material, as asphalt or cement; the other is to draw the cables into a previously constructed conduit. Neither method is free from disadvantages when compared with the ideal subway, but the conduit plan seems to have less than the other, and to offer some advantages which are a fair return for the additional expense. In the choice of a method of protection all the local conditions are to be considered, and a plan which is successful in one place may be a failure in another.

The third class of objections we see are financial. It needs no argument to show that it will cost a great deal more to put all the wires of an exchange underground than to carry them on poles and house tops. Saying nothing about its theoretical advantages, air is by far the cheapest insulator known. The insuperable part of the financial difficulty is the proposed throwing away of a full equipment of lines which are in working condition, and replacing them by an entirely new and more expensive system. To even overcome the difficulty due to the difference in cost, the exchange must be made gradually—no faster than the existing lines need renewal.

After all this enunciation of the difficulties in the way of underground service, it may seem that we have left no useful field for it. But there is an extensive field open to such service, and we wish only to look at the matter fairly and impartially, recognizing the existence of serious obstacles which cannot be dismissed with a word. We are convinced of the existence of certain limitations which have been enumerated. We are also convinced that within these limitations there are no reasonable doubts of the perfect success of underground service, as far as any electric troubles are concerned; that while no rigid system may suit all places, there are no mechanical difficulties that cannot be solved by attention to the local conditions; and finally there are no financial objections which are more far reaching than the others, or which would be serious if the change were made gradually. In the proper municipal supervision of electric wires there seems to be an exact parallel with supervision over buildings. When a city reaches any considerable size, the general welfare demands the establishment of fire limits within which the use of inflammable building material shall be restricted. But it has never gone to the extent of compelling owners of wooden buildings within these limits to tear down their structures and replace them with fire-proof material; neither has it forbidden the use of wood in subordinate parts of the structures, or wooden palings and gates in residence streets. It does not refuse permission to prolong the life of wooden buildings by keeping them painted, or by stopping leaks in the roof or replacing broken glass. When a great number of wires accumulate in a neighborhood so as to be a nuisance, it is perfectly proper for those who have the welfare of the city in charge to say that the line must not be rebuilt except underground. But what is the difference between ordering the demolition of a line of poles and wires and the demolition of a wooden building because both are liable to endanger adjacent structures in case of fire, and because both are more useful than ornamental?

The idea of putting all the wires in any city underground throughout their whole extent is not worthy any discussion—it is entirely impracticable. But in any large city the number of wires in the neighborhood of the exchange is a nuisance, both to the public and to the company, and there is no objection, scientific, mechanical or economic, to putting them underground for moderate distances, until they begin to diverge and scatter to reach individual subscribers. In some cases it is absolutely necessary to cable the wires in order to handle them, and there is very little difference in the working of any aerial and underground cables—none at all if they are inclosed in metal. It would be advantageous to use a special conductor for trunk lines and long extra territorial circuits. This is about all that can be done with the present apparatus, and with our present knowledge of the methods of overcoming the difficulties in the way. It is all that has been done in any place, and all that any body of lawmakers can compel to be done successfully. It is doubtful if there is a large exchange in the country that would not voluntarily do as much when the present pole lines need rebuilding. The most conclusive experiments that have been made, and the most extensive work that has been done thus far, have not been under compulsion, but voluntarily. It does not seem that at present we have sufficient data to say absolutely just what length of wire can be worked underground. We are sure that the entire system of any large city cannot be put underground for good scientific and financial reasons. We are sure that the entire system of any small exchange cannot, for financial reasons alone. We are sure that a general and extensive local adoption of underground wires would prevent long distance telephoning, except perhaps from office to office. On the other hand, we are sure that when it is required to handle a large number of wires in a small space for a moderate distance, no one need fear any bad results from using underground cables. The only thing we are not sure of is the exact length of a "moderate distance." But it is probable that no trouble would be experienced in any place up to the limit of 100 wire cables—that is, as far from any office as any 100 wires pursue the same route.

In conclusion, to state our creed, we believe in both aerial and underground wires, without bigotry or intolerance towards either, and with due recognition of a suitable and proper field for the use of each. We do not have much faith in the man who says he can put 2,392 wires in a space 2⅞x3¼ inches; neither do we expect a lineman will be a necessary feature of every circus of the future, to show people how they used to climb poles in the old days of telephone wires.

The paper was received with applause.

The paper of the president, Mr. C. N. Fay, which followed Mr. Patterson's paper, discussed much the same question, and some additional suggestions on the subject were presented for the consideration of the convention. Mr. George F. Durant occupied the chair during its reading. The paper, like its predecessor, was

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listened to with marked interest, and ordered placed on the records.

The papers were discussed in common, Mr. Thomas D. Lockwood, of Boston, presenting the report of the select committee of the British House of Commons on the subject, and W. D. Sargent, of Brooklyn, gave the experience of the companies in that city.

General Thomas Sherwin, auditor of the American Bell Telephone Co., read a paper on "Telephone Accounts," in which he discussed some of the existing methods of keeping the books of the companies, and presented his idea of a practical and efficient scheme. The paper was in the line of the ideas held at headquarters to establish a uniform system of keeping accounts in the various offices, and provoked much discussion and many additional suggestions.

The session was adjourned at 5 o'clock.

THURSDAY, SEPTEMBER 10.

The last paper of the meeting was read by J. J. Carty, of Boston, giving interesting details of the practical operation of the multiple system of switchboards, as operated in the Boston exchange, where it is believed they have attained their highest present development. The paper and its discussion elicited some points regarding the number of calls answered daily by exchange operatives, which appeared incredible to many delegates. Nashville, Tenn., with 2,500 calls, stood at the head, which is perhaps accounted for by the fact that the local company's stock is very generally distributed in the city, and that every employé of telephone subscribers is expected to answer a call instanter in order to facilitate business. The records of various exchanges were referred to, but it was apparently the general belief that 1,000 calls per operative each day was more than should be exacted.

Mr. Lockwood gave a general history of the patent litigation during the past year, and expressed the opinion that the parent company had never stood in a better condition as regards patents than at the present time.

Mr. Metzger invited the association to meet at Pittsburg in 1887, at which time he believes the city will be free from smoke, on account of the general adoption of natural gas for fuel.

At 12:10 P. M. the meeting adjourned *sine die*.

Most of the delegates, with a number of invited guests, accepted the hospitality of the Providence Telephone Co., and embarked at 1 P. M, on the propeller "Philadelphia" for an excursion down Narragansett Bay.

The weather had been raw and disagreeable during the forenoon, but rapidly improved, and the trip was thoroughly enjoyed by all. A bountiful lunch had been provided, and a well-filled punch-bowl placed well forward and exactly in the centre, that the boat might keep an even keel. Notwithstanding all precautions, however, the heel struck a hidden rock and created a momentary sensation on board, some of the passengers in their anxiety seeking the life-preservers, while at least one was actually put on. The boat was put about when opposite Bristol and returned to Providence, reaching the wharf at about 5 o'clock. There was a general expression of satisfaction at the unremitting attention of Messrs. White and Duxbury in anticipating every want of the visitors, and they were heartily seconded in their efforts by many Providence gentlemen on board.

THE MANUFACTURERS' EXHIBITS.

The earlier telephone conventions offered a better field for the exhibition of switchboards, magneto-bells and kindred apparatus, as interest was largely directed toward the improvements introduced in these devices by rival manufacturers. At the present time more attention is being given to the proper construction of lines, and consequently improved wire and cables formed the larger proportion of the electrical goods shown.

The most prominent and important collection of samples was shown by the American Electrical Works, of Providence, and it is a satisfaction to note the steady improvement which has been made in the finish and perfection of the products of this enterprising establishment. Office and annunciator wire, rubber insulated, both plain and lead covered, office and aerial cables, with anti-induction devices, telephone, incandescent lamp and switch cords, taken as a whole, made a very interesting display. The fine copper wire drawn by Mr. Sawyer's process, received general commendation, it being of uniform diameter throughout, while pieces were shown of extraordinary length, one a five mile piece of .005 diameter, another weighing 12 ounces, .003 diameter. Similar pieces were also shown silk covered. None of the gentlemen present were seen to measure these pieces, they being sure that the labels from this factory never tell a lie.

The Western Electric Company exhibited specimens of various conduits in which the Patterson cables were being used, among them the Dorsett of Chicago, and the wooden conduits used by the Chesapeake and Potomac Company in Washington, and the New York and New Jersey Telephone Company in Brooklyn. A village telephone system dispensing with a central office also attracted considerable attention.

The kerite wire and cables of A. G. Day were shown by Mr. Hotchkiss. All of the standard varieties so well known to the electrical community were there, also specimens of heavily armored submarine cable which has been quite generally adopted for use in the vicinity of New York city, for both telegraph and telephone work, by the Western Union, Baltimore and Ohio, Bankers and Merchants', and Postal companies, and the American Telephone and Telegraph Company.

A very fine exhibit of the Waring lead covered wire and cable was shown by the Standard Underground Cable Co. of New York and Pittsburg.

The Washburn and Moen Manufacturing Company, of Worcester, showed that they keep abreast of the times by a handsome coil of hard-drawn copper wire as the most conspicuous object of their attractive display. In giving their attention to copper wire, however, they have by no means neglected the manufacture of iron, which finds a growing market for fencing purposes.

The Bridgeport Brass Company made a fine display of various sizes of copper wire.

The Okonite Company, of New York, besides samples of their insulated wire, which is rapidly growing in favor, exhibited Mr. J. J. C. Smith's underground system, in which armored cables are used with a very complete arrangement for the connection of wires in the joint boxes.

The Clark Insulated Wire Company showed a variety of samples of rubber covered wire, both with and without the fibrous covering. Line wire of copper, iron and steel, with similar insulation, also formed a part of this exhibit.

The Callender Insulating and Waterproofing Company, in addition to numerous samples of wires and cables insulated with bitite, exhibited elaborate plans of their underground system.

The Standard Electrical Works of Cincinnati exhibited samples of their magneto call-bells, and of the Stevens telegraph key.

The following list of delegates and visitors was in attendance:

Angell, Fred. H.—American Electrical Works, Providence, R. I.
Allen, B. A.—Providence.
Brown, J. M. } Special Agents, American Bell Telephone Co., Boston.
Boyd, Robt. S. }
Baker, Hugh C.—Bell Telephone Co. of Canada, Toronto.
Barney, C. H.—Supt. New York and New Jersey Teleph. Co., Jersey City.
Baker, Ellis B.—Gen. Supt. Southern New England Teleph. Co., New Haven.
Bryan, Samuel M.—Chesapeake and Potomac Teleph. Co., Washington. D.C.
Bailey, R. M.—Central Pennsylvania Telephone Co., Williamsport, Pa.
Barton, E. M.—Vice-president Western Electric Co., Chicago.
Beane, John W.—Consulting Electrician, *Electrical Review*, New York.
Bliss, George H.—Bliss Individual Signal Co., Pittsfield, Mass.
Bailey, Henry L.—Telegraphic Time Co., New York.
Bowen, H. A.—Rhode Island Electric Lighting Co., Providence.
Carson, D. I.—General Supt. Southern Bell Teleph. Co., New York.
Cole, W. J.—District Supt. Southern Bell Teleph. Co., New York.
Cranston, Henry C.—Vice-president Providence Telephone Co., Providence.
Cutler, C. F.—President New York and New Jersey Telephone Co., Brooklyn.
Clark, Joel C.—Treasurer New York and New Jersey Teleph. Co., Brooklyn.
Carty, J. J.—New England Telephone and Telegraph Co., Boston.
Cowles, S. H.—General Manager Bell Telephone Co., Buffalo, N. Y.
Cull, W. H.—Hudson River Telephone Co., Albany, N. Y.
Clark, James—Ohio Valley Telephone Co., Louisville, Ky.
Candee, W. L.—Treasurer Okonite Co, New York.
Cherry, E. V.—Vice-president Standard Electrical Works, Cincinnati.
Callender, W. M.—Callender Insul. and Waterproofing Co., E. Newark, N. J.
Crawford, John—Late Chief Engineer International Bell Teleph. Co., Russia.
Carhart, E. M.—Providence, R. I.
Coop, W. L.—Narragansett Machine Co., Providence.
Childs, W. A.—Law Telephone Company, New York.
Dana, R. K.—Agent Washburn & Moen Mfg. Co., New York.
Driver, William R.—Treasurer American Bell Telephone Co., Boston.
Doolittle, T. B.—Special Agent American Bell Telephone Co., Boston.
Duxbury, J. W.—General Manager Providence Telephone Co., Providence.
Durant, Geo. F.—General Manager Bell Telephone Company of Mo., St. Louis.
Darling, J. O.—American Electrical Works, Providence.
Davis Edward—Davis Individual Call System, Cambridge, Mass.
Douglass, C. H.—Providence Electrical Supply Co., Providence.
Eckert, W. H.—General Supt. Metropolitan T. & T. Co., New York.
Easterlin, John D.—Dist. Supt. Southern Bell Teleph. Co., Charleston, S. C.
Eastabrook, W. N.—New York and Pennsylvania T. & T. Co., Elmira, N. Y.
Fay, C. N.—General Manager Chicago Telephone Co., Chicago, Ill.
French, C. Jay—Asst. Genl. Manager American Bell Telephone Co., Boston.
Fowler, J. J.—Genl. Man. Great Southern Teleph. Co., New Orleans.
Frost, H. P.—Genl. Man. South. New England Teleph. Co., New Haven, Ct.
Fenner, H. N.—New England Butt Co., Providence, R. I.
Gilliland, E. T.—Boston, Mass.
Glidden, Charles J.—Lowell, Mass.
Goodyear M. W.—E. S. Greeley & Co., New York.
Hall, Edward J., Jr.—Genl. Man. American Teleph. & Telegraph Co., N. Y.
Howard, Gov. Henry—President Providence Telephone Co., Providence.
Hudson, J. E.—General Manager American Bell Telephone Co., Boston.
Hotchkiss, Clark B.—Day's Kerite Wire and Cable, New York.
Harrington, F. W.—Western Electric Co., New York.
Ivers, Samuel—New Bedford, Mass.
Jepson, J.—Dist. Supt. Southern New England Telephone Co., Norwich, Ct.
Keller, J. N.—New England Telephone and Telegraph Co., Boston, Mass.
Ker, Wm.—General Manager Pennsylvania Telephone Co., Harrisburg, Pa.
Kinsey, Isaac—Standard Electrical Works, Cincinnati, O.
Kinsey, E. A.—Standard Electrical Works, Cincinnati, O.
Lockwood, T. D.—Electrical Dept. American Bell Telephone Co., Boston.
McCluer, C. E.—Dist. Supt. Southern Bell Telephone Co., Richmond, Va.
Morgan, A. O.—Special Agent American Bell Telephone Co., Boston.
Metzger, Henry—Gen. Man. Cent. Dist. and Printing Telegraph Co., Pittsburg.
Mason, Col. Fred. A.—Bridgeport Brass Co., Bridgeport, Ct.
Martin, T. C.—Associate Editor *Electrical World*, New York.
Marsh, J. W.—Standard Underground Cable Co., New York.
Nicholson, C. A.—Utica, N. Y.
Newell, F. A.—Bradford, Penn.
Oram, J. M.—Oram Telephonic Time Co., Boston.
Pendleton, John M.—President Equitable Electric Co., N. Y.
Patterson, W. R.—Western Electric Co., Chicago.
Price, Chas. W.—Associate Editor *Electrical Review*, New York.
Pope, R. W.—Associate Editor ELECTRICIAN AND ELECTRICAL ENGINEER, N. Y.

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Phillips, Eugene F.—President American Electrical Works, Providence.
Palmer, J. A.—Genl. Manager Brooks Underground Cable Co., Philadelphia.
Powell, Major J. B.—General Manager Brush-Swan Co., Boston.
Reilly, J. C.—Dist. Supt. New York and New Jersey Teleph. Co., Brooklyn.
Rolfe, C. A.—Western Electric Co., New York.
Sunny, B. E.—Superintendent Chicago Telephone Co., Chicago, Ill.
Seely, J. A.—Electrician Metropolitan T. and T. Co., New York.
Sherwin, General Thomas—Auditor American Bell Telephone Co., Boston.
Starkweather, J. M.—Director Providence Telephone Co., Providence.
Storke, H. L.—Empire State Telephone and Telegraph Co., New York.
Sise, Charles F.—Bell Telephone Co. of Canada, Montreal.
Sargent, W. D.—Genl. Man. N. Y. and N. J. Teleph. Co., Brooklyn, N. Y.
Stone, Geo. N.—Genl. Man. City and Suburban Teleph. Assoc'n, Cincinnati, O.
Speed, J. B.—Ohio Valley Telephone Co., Louisville, Ky.
Smith, Henry M.—Washburn & Moen Mfg. Co., Worcester, Mass.
Smith, J. J. C.—Okonite Company, New York.
Stanley, Henry D.—Bridgeport Brass Co., Bridgeport, Ct.
Shippy, Henry L.—Manager John A. Roebling's Sons Co., New York.
Stump, Clarence E.—Business Manager *Electrical World*, New York.
Sawyer, Wm. H.—Secy. and Electr'n American Electrical Works, Providence.
Truex, C. R.—Special Agent American Bell Telephone Co., New York.
Tyler, Morris F.—President Southern New England Teleph. Co., New Haven.
Thayer, H. B.—Western Electric Co., New York.
Thomas, Van A.—Supt. Narragansett Electric Light Co., Providence, R. I.
Uline, A. B.—Hudson River Telephone Co., Albany, N. Y.
White, A. C.—Superintendent Providence Telephone Co., Providence.
Wilson, A. Jr.—Chesapeake and Potomac Telephone Co., Baltimore.
Wilson, J. Chester—Genl. Manager Clark Insulated Wire Co., Philadelphia.
Waring, R. S.—Standard Underground Cable Co., Pittsburg, Pa.
Wiley, George L.—Standard Underground Cable Co., New York.
Welch, E. Baker—Davis Individual Call System, Cambridge, Mass.
Woodbury, C. J.—Boston, Mass.

THE RHODE ISLAND CLAMBAKE OF 1885.

Although several of the telephone delegates left Providence after the final adjournment of the annual meeting, their number was more than made good by the arrivals on Friday morning, September 11, of electrical gentlemen who gathered from various quarters to participate in the festivities accompanying the seventh annual clambake tendered to the fraternity by Eugene F. Phillips, president of the American Electrical Works.

The gathering was announced to take place upon the grounds of the Vue de L'Eau club on the eastern shore of Narragansett Bay, and the 10 o'clock boat from Providence landed the first installment of Mr. Phillips's guests, who were followed at intervals during the day by delayed delegations, until an assemblage of about 125 were gathered on the grounds. Each guest upon arrival ascertained that by simply registering his name he would receive a very appropriate souvenir of the day in the shape of a light cane braided at the American Electrical Works, the head being formed of a very perfect imitation of the Bell receiving telephone. Suspended from it by a conducting cord was a miniature silvered clam, emblematic of the occasion.

In order to put themselves in proper condition for dinner at 3 o'clock, a large proportion of those present immediately engaged in athletic sports, such as foot-ball, base-ball, archery and clay-pigeon shooting. The weather was simply perfect, and suitable either for out or indoor amusements. Several gentlemen who prided themselves on their blowing capacity, were quietly introduced to an ingenious lung-tester which had been prepared for the occasion by a Providence joker. The victim was led on by a "steerer," who, as he demonstrated the principle of the machine, turned a switch in the rear which left it loaded with a charge of flour. The new comer, in his anxiety to beat the record, retired from the scene thoroughly deluged with a sprinkling of flour, which was belched forth by the sudden blast of air from apertures on either side of the harmless looking machine. We regret to say that some of our shrewdest New Yorkers were inveigled into this trap by the artless clam-diggers of Rhode Island.

The two base-ball nines, which were organized and commanded by J. O. Darling, of the American Electrical Works of Providence, and F. B. Knight, of New York, engaged in a match which resulted in a victory of the Darling side by a score of 42 to 13.

A continuous lunch was on hand for the benefit of those who could not wait until dinner was served. Other wants of the inner man were likewise provided for in the immediate vicinity. The call to dinner at 3 o'clock was promptly responded to, and the neatly laid tables were immediately surrounded by the largest gathering of electrical representatives which has ever convened upon one of these pleasant occasions. Mr. Eugene F. Phillips read letters of regret from governor Wetmore, mayor Doyle and Stephen D. Field, following with the introduction of Ralph W. Pope, to whom, as a former resident of Providence, he had delegated the duty of welcoming his guests. The preliminary formalities being thus disposed of, the attention of the gentlemen present was readily diverted to the abundance of good things which were successively placed before them. The material being of the best, and its manipulation superb, it was the universal verdict that notwithstanding the success of previous "bakes," the last effort surpassed them all. Nothing can be more certain than that Messrs. Phillips and Sawyer, with their able assistants, Angell and Darling, have again added to their laurels by providing one of the most perfect days of entertainment which could possibly be devised. Such occasions are of substantial value in renewing bonds of friendship and establishing general good feeling among the now numerous branches of the business.

The day closed with the return trips of the shore steamers at 5 and 6 o'clock, which carried back to Providence a most thoroughly satisfied band of excursionists, filled with enthusiasm as to the beauties of Narragansett Bay and the thoroughness of the welcome which little Rhody extends to those who visit her classic shores.

The following is a list of the gentlemen present, who figure in a photographic group which was taken on the occasion:

Adams, George W., Boston.
Allen, C. C., Boston.
Allen, B. L., Providence.
Addeman, J. M., Providence.
Angell, F. H., Providence.
Bailey, H. L., New York.
Bunnell, J. H., New York.
Bly, Charles L., Boston.
Boyd, R. S., Boston.
Brooks, Morgan, Boston.
Blodgett, George W., Boston.
Breckenridge, L. W., Providence.
Busnell, F. T. C., Providence.
Bradford, H. C. Providence.
Burdon, L., Providence.
Bair, W. W., Philadelphia.
Bailey, R. M., Williamsport, Pa.
Barker, E. B., New Haven.
Burgess, P. G., Newtonville, Mass.
Barney, C. H., Jersey City.
Candee, W. L., New York.
Carty, J. J., Boston.
Clark, J. H., Boston.
Canfield, F. P., Boston.
Carr, Rufus B., Boston.
Crofut, W. S., Providence.
Carhart, E. M., Providence.
Cranston, H. C., Providence.
Chace, J. H., Providence.
Cull, W. H., Albany, N. Y.
Crawford, John, Russia.
Downs, Loren N., Boston.
Dempster, W. W., Providence.
Darling, Geo. H., Providence.
Duxbury, J. W., Providence.
Davis, Abiel F., Providence.
Douglass, W. W., Providence.
Drake, Jno. I., Providence.
Darling, J. O., Providence.
Doolittle, T. B., Bridgeport.
Daboll, F. G., Springfield.
Edmunds, Henry, London, Eng.
Frary, W. R., New York.
Fahey, P., Boston.
Frenyear, T. C., Boston.
Fisher, W. M., Attleboro.
Fowler, J. J., New Orleans, La.
Frost, Ellis F., Pawtucket.
Goodyear, M. W., New York.
Gilliland, E. T., Boston.
Gardiner, F. H., Providence.
Hotchkiss, Clark B., New York.
Hunter, M. E., New York.
Hall, W. A., Boston.
Hannaford, F. A., Boston.
Howard, Albert, Boston.
Howard, Chas. T., Providence.
Howard, E. H., Providence.
Hurlburt, P. J., Providence.
Hathaway, W. A., Providence.
Joyce, W. H., Providence.
Jepson, J., Norwich, Conn.
Klein, Charles J., New York.
Kempster, James, New York.
Knight, F. B., New York.
Kingston, J. C., Boston.
Ker, Wm., Harrisburg.
Leslie, E. A., New York.
Lytle, F. M., Boston.
Lytle, H. B., Boston.
Lewis, M. S., Boston.
Lillie, N. W., Boston.
Learned, W. B., Boston.
Lincoln, Chas. E., Providence.
Langstaff, H. C., Providence.
Levett, H. H., Philadelphia.
Morse, J. S., New York.
Marsh, J. W., New York.
Martin, T. C., New York.
Miller, Henry J., Boston.
Metcalf, E. W., Boston.
Manson, George T., Boston.
Millard, Geo. W., Providence.
Munro, W. N., Providence.
Mitchell, D. L. Taunton.
Mason, R. D., Pawtucket.
Newell, F. A. Bradford.
Pope, R. W., New York.
Price, Chas. W., New York.
Perkins, C. A., Boston.
Pettengill, H. J., Boston.
Phillips, Eugene F., Providence.
Peterson, C. G. A., Providence.
Pratt, J. W., New Bedford.
Phipps, C. B., Philadelphia.
Parker, M. G., Lowell.
Robertson, G. M., New York.
Robinson, R. T., Providence.
Remington, C. R. Jr., Providence.
Reilly, J. C., Brooklyn, N. Y.
Reise, Frank, Philadelphia.
Royce, Fred. W., Washington.
Stump, C. E., New York.
Seeley, J. A., New York.
Speer, Geo. B., New York.
Sheehan, C. J., Boston.
Smith, W. M., Boston.
Sawyer, W. H., Providence.
Sims, Gardiner, Providence.
Sherman, Henry H., Providence.
Sargent, W. D., Brooklyn, N. Y.
Sherman, W. R., New Bedford.
Sunny, B. E., Chicago.
Shepardson, A. O., Waterbury.
Sylvester, Chas., Fall River.
Stedman, W. H., North Adams.
Shove, Isaac, Pawtucket.
Stone, Geo. N., Cincinnati.
Starkweather, J. U., Barrington, Mass.
Truex, C. R., New York.
Thornberry, H. S., Boston.
Thomas, V. A., Providence.
Thompson, C. S., Brooklyn, N. Y.
Taber, R. S., New Bedford.
Underhill, Jno. B., New York.
Williams, H. M., New York.
Wetmore, J., A., New York.
Wiley, G. L., New York.
Williams, J. J., Boston.
White, A. C., Providence.
Whittier, R. H., Providence.
Wright, A., Providence.
Wagner, W. R., New Bedford.
Willard, W. H., Worcester.
Wyman, J. C., Valley Falls.
Wilson, A. Jr., Baltimore.
Young, A. M., Waterbury.

THE ELECTRICAL SUBWAY COMMISSION.

The New York commissioners met on August 31 at their permanent quarters, No. 23 West 23d street.

An elaborate plan for an underground system was submitted by Thomas Wallace, 150 Broadway, who proposed the construction of a main tunnel from the Battery to 14th street, sufficiently deep to pass under the gas mains and sewers. The tunnel can also be used for the new water supply in addition to the wires.

J. Hollins Bowly, of Jersey City, presented a description of a conduit to be constructed in sections of either iron or wood.

C. D. Shrieves, of the firm of Shrieves & Cook, of Philadelphia, submitted a plan of a terra-cotta conduit.

Dr. Norvin Green, president of the Western Union Telegraph Company, appeared before the commission to explain what had already been accomplished by that company in underground work. His statement was substantially as follows:

We have an underground system in New York. Wires are run underground from the main office, corner Broadway and Dey street, to the Cotton, Produce and Stock Exchanges, also to the ferries at the foot of Cortlandt and Liberty streets. There are 120 wires to the ferries. We also have tubes laid up Broadway to 23d street. We use gutta-percha insulated wires in iron tubes. We find that this system gives the best satisfaction to ourselves and the least annoyance to the public.

We have tried Brooks's insulation. If it should prove a success, it will afford the cheapest system. In this the wires are covered with cotton, and are drawn through iron tubes which are kept full of paraffine oil. The wires work well so long as the

oil remains pure. A great deal of care is required to make this system satisfactory.

The advantage of a tube is that defective wires can be drawn out and replaced, it being important that the streets be not disturbed.

We use 4-inch pipe, beside the pneumatic tubes, which are of brass. Iron tubes in long pieces afford easy means of drawing cables in and out.

We have *some* poles on Broadway, but our most important lines are on 3d and 4th, 6th and 7th avenues. Our branch offices on Broadway can be served from the line to 23d street. We can place 100 wires in each pipe. It depends on the heaviness of the insulation.

The Brooks system is not inexpensive. The insulated wire alone is worth $100 per mile, against $22 per mile for overhead wire, while the wire does not last as long as it does when strung on poles. We have just taken down some wire that had been up thirty years in the country. The insulation does not last as long underground as it does under water. The average duration under water is from eight to ten years. Many new forms of insulation have been presented to us, but nothing which was satisfactory or lasted over a year.

The system used by us is the same as used in England. The Brooks system has been more satisfactory in Chicago than in this city. I do not think telegraph and telephone wires should go in the same ditch if it can be avoided. The telephone people do not wish to have their wires go in with those of the telegraph companies. People tell us that they have good systems, but we have seen none of them. We can go in with the telephone wires if they can stand it, but do not wish to go with the electric light wires. Neither the district, telephone nor fire alarm wires affect ours.

Our quadruplex wires carry pretty heavy currents, and are pretty hot sometimes. We shall this autumn draw in wires up to 23d and perhaps to 42d street, thence through the tunnel. Some of our branch offices at the exchanges can be reached by underground wires.

The telephone company has three times the mileage of wire that we have, although our wires cover a larger area.

The difficulty is to meet the requirements of the law, without impairing the service. Wherever this is done the result is detrimental to the service. The wires used underground are small, and practically add to the length of the line, being of less conductivity. Such wires cannot be worked as fast. The average speed over the ocean cables is but 12 words per minute, while our Morse system averages 30 and the Wheatstone 130. The retardation is not practically perceptible for distances of two or three miles, but the trouble is that if the wires are buried in New York other cities will follow.

Commissioner Hess—How about Germany? Have they not an extensive underground system?

President Green—They are not putting them underground in Germany as much as they were. It is a government service and the public are not so exacting as here. The city service in London is splendid. There is a special wire to each office. Here we have six, eight or ten offices on a wire, and we have 147 offices in the city. Sometimes when they have business they are obliged to wait until they can get in. The service is not as good as it should be. The city service in London is so good that the district telegraph has stood no show.

The various railways come pretty well into London. With the exception of the Paddington railway none of them are over a mile from the post-office, while some terminate not more than 600 feet away. They come in on viaducts of masonry, upon which the wires are strung on little iron poles. The underground work extends from these several stations to the post-office. The Metropolitan Underground Railway also extends all round the city, affording good facilities for wires. There are more wires overhead than underground, however.

Commissioner Moss—Could not your company utilize the elevated railroad structures? In the original plans of Dr. Gilbert he made provision for both gas and telegraph systems.

President Green—Yes, we could use the elevated railway structures, and we have the privilege on the 3d avenue line. It is not, however, feasible to place pneumatic tubes overhead. The question was considered by our engineers, but it was decided that the changes in temperature would render it impossible to keep them in working order. The pneumatic service is destined to become very important. The time between Dey street and 23d street averages about two minutes. Twenty-five or thirty messages may be sent at a time in a box. Letters or small packages may also be sent. The day we started the pneumatic tubes we took 16 operators off the wires, at the same time improving the service.

At the request of the commissioners, president Green stated that he would send up a map of their lines in the city.

Mr. George D. Sutton, of 146 West 10th street, submitted a model of a system, in which a cast-iron conduit is substituted for the existing curbstones. He had no plan of separating the electric light from other wires.

Mr. W. O. Callender submitted plans for burying the wires, he having given especial attention to the electric light service. He did not believe it practicable to place all the systems together.

At the meeting on September 7th, a communication was received from the Department of Public Works, enclosing a list of all permits which had been granted for the use of the streets of the city for electric wires.

Mr. Bentley, of the Bentley-Knight Electric Railway Co. presented plans of a subterranean system, and also gave a verbal description of the cable which they proposed to use which would obviate all disturbances from induction upon telephone wires which might arise from telegraph and electric light wires running parallel to them. It was well known that metallic circuits would avoid this difficulty, but the doubling of the number of wires in use would be a great undertaking. In the Bentley-Knight system, induction is avoided by the adoption of a similar plan, in which however a single conductor of large capacity is introduced in each cable which is utilized as a general return for all the other conductors in the cable. Plans were exhibited of a conduit made of prepared wood, the positive electric light wires being provided for on one side, the negative on the other with the telephone wires occupying the space between them. Mr. Bentley stated that the main feature of the plans presented was the cable, there being various patterns of conduits which could be utilized.

Hon. A. Macdonald, of Pennsylvania, submitted the Averell system, in which bare wires are imbedded in a solid mass of asphaltum and silex.

John B. King, of New York, proposed to utilize the present sewerage system of the city, by digging down and clearing off the surface of the brick structures which are then to be treated with a coat of asphaltum, and an additional shell of brick laid up outside of the sewers, the space between them being utilized for wires, which are to be strung on iron arches and insulated with glass beads covered with bituminized cloth. He was somewhat fearful that his plan would be appropriated without proper regard for the inventor's rights

Mr. Alguber showed a model of a wooden tube formed of tongued and grooved strips, which he claimed could be furnished 50 per cent. cheaper than anything else, while there was no necessity of placing it more than one foot below the surface.

Mr. Theodore Betzel submitted an elaborate plan by which he proposed that conduits should be built through the blocks instead of beneath the streets. The wires are then to be brought up through a manhole located in the centre of each block, thus requiring but one manhole in each.

Gen. Averell gave further details of the system submitted by Senator Macdonald at the previous meeting.

At the meeting on September 14th, President Loew submitted the following resolution which was adopted:

Resolved, That to afford reasonable facilities to inventors and others for the final submission of plans for electrical subways, this commission continue its regular meetings for that purpose till the 15th day of October next instant. and that thereafter this commission proceed to cause to be devised, the plan of electrical subways intended by the law governing this commission.

Superintendent George B. Scott, of the Gold and Stock Telegraph Co. requested permission to run a cable overhead across the pavement to reach the rear of No. 658 5th avenue near 46th street. His application was referred to Commissioner Hess to investigate and report.

General Averell, representing the Averell Insulating Conduit Co., stated that it was not contemplated in any other system to lay down naked wires but such was the plan he proposed. The compound used for insulation is formed from silica and asphalt. He had experimented two years in producing a suitable material for pavements which was a still more difficult problem than this. The proportion of asphalt required is determined by the void in the silica. In a cubic foot, or 1,728 cubic inches of silica, there was about 540 inches void, which is the measure of the asphalt to go in, but as the asphalt shrinks when cold it is also necessary to determine the amount of shrinkage. The material is impervious to water and is laid down at a temperature of 230°. It is a non-conductor of heat as well as of electricity. As an insulator the asphalt is superior to rosin, and the silica to glass. The asphalt is as sensitive as mercury to the changes of temperature, but when combined with sand it simply fills the void and in its shrinkage binds the particles together forming a mass as hard as granite, beyond which point it cannot contract underground. A slab an inch thick may be placed on a red hot iron, and it will be a long time before the heat will pass through it. No acid, alkali or gas will affect it, it being simply imperishable. All conductors must be insulated. Dry air is the best of insulators. The insulation of this material has however never been questioned. By this system 100 wires may be laid down at half the cost of the cheapest yet proposed. The cost of construction being so small and its permanency unquestioned, the cost of maintenance is actually nothing.

Regarding a system for New York city, General Averell said the following systems must be provided for:

1st. Telegraph wires, including private lines.
2d. Telephone wires.
3d. Signal service *i. e.*, district, burglar and fire alarms.
4th. Quotation and general news wires.
5th. Arc and incandescent lighting wires.
6th. Motors.

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To estimate the entire cost it would be necessary to know the mileage. There were 1,848 telegraph and 101 other wires crossing 14th street on pole lines. He proposed to reach every block in the city with every system. To do this would require about 20 miles of main conduits, 40 miles of branches and about 340 miles of "twigs." They were perfecting a system of manholes which by permitting the use of switches would reduce the mileage, thus lessening the cost and increasing the efficiency.

At the meeting on September 16th, secretary Moss introduced the following resolution which was adopted.

Resolved, That the Commissioners of the Fire Department be respectfully requested to inform this board if they permit any electric light companies to place any of their wires on the poles belonging to the fire department.

The board subsequently adjourned until September 29th, after which it is proposed to hold daily sessions until the 15th day of October.

JUDGE WALLACE'S DECISION IN THE DUPLEX SUIT.

THE WESTERN UNION TELEGRAPH CO. *v.* THE BALTIMORE AND OHIO TELEGRAPH CO.

United States Circuit Court, Southern District of New York.

Decided September 26.

WALLACE, *J.*:

The complainant moves for a preliminary injunction to restrain defendant from infringing the second claim of Reissued Letters Patent 10,035, Div. C., granted to Joseph B. Stearns, assignor to complainant for "duplex telegraph apparatus."

The motion was resisted on the ground that there was no patentable novelty in the alleged invention, and that the reissue is void because it includes that part of the invention which had abandoned to the public by the delay on the part of the patentee in applying for a reissue.

The original patent was granted to Stearns May 14, 1872; it was reissued April 1, 1873 (No. 5344), and was again reissued in divisions A, B, and C, February 7, 1882.

No doubt whatever is entertained that Stearns was the first and original inventor of a very valuable improvement in duplex telegraphy, which obviated a serious practical difficulty in duplex transmission over long lines, caused by the interference of the return charge arising from static induction with the operation of the receiving instrument at the transmitting end. He did this by a new combination of old instrumentalities. He added to the existing duplex telegraph a condenser so placed that it would receive a charge from the battery equivalent to the charge which the line at the same time received, and would discharge that charge around one coil of the relay at the same time the line discharged its charge around the other coil, so that the armature between the two coils would not be moved by the discharge from the line. As is stated in the affidavit of one of the defendant's experts, no one before Stearns had endeavored to obviate the effects of the static induction upon the receiving instrument in duplex telegraphy with the exception of Varley, and the device used by Varley was not a condenser nor was it in any sense the known equivalent of a condenser.

The invention thus made by Stearns was fully and clearly described in the specification of the original patent. The claim of that patent upon one construction may be deemed to have been narrower than the real invention. This, however, would affect only the question of infringement. A new and valuable invention was described and claimed. It is not necessary in considering the first objection to the validity of the patent to inquire into the prior state of the art. The defendant's expert says: "The claim does not appear to cover any more than the patentee had a right to claim in view of the state of the art at that date." This concession renders such an inquiry unnecessary; but the concession is abundantly fortified by the facts as they appear upon this motion.

The real question in the case would seem to be whether the reissue, so far as it affects the claim infringed, is void.

The claim involved is as follows:

2. "The combination in a duplex telegraph substantially as heretofore set forth, of a battery, a main line, and artificial or compensating line, a rheostat in said artificial line, and a condenser having its terminals respectively connected with said artificial lines and the earth."

The claim of the original patent read as follows:

"In telegraph apparatus for double transmission, the combination with the relay at each station of a condenser, for the purpose of neutralizing the effect of the return current due to the static induction of the line, as set forth."

If the case turned solely upon the question whether the claim of the reissue is broader than that of the original, a sufficient doubt would be suggested to require a motion for an injunction to be denied, because a fair doubt is sufficient to defeat such a motion.

The claim of the original may fairly be construed as limited to a combination in which a condenser is employed in connection with the relay at each station upon a duplex telegraph line. Of course a duplex telegraph implies a line with a receiving and transmitting station at each end of it. The drawings of the patent show only one end of such a line, and the specification of the original describes the apparatus in detail, including a condenser, a battery and a branch circuit or compensating line with a rheostat in it, at that end of the line shown in the drawing. It may fairly be assumed that the claim was expressed in the terms used in order to exclude any implication that the invention consisted in employing the condenser at one end of the line or at one station only.

The real invention of Stearns did not require his condenser to be employed in combination with the rest of the apparatus at both ends of the line. If a condenser were used with the apparatus at one station only the static effect of induction would be neutralized at that end of the line only. The combination would be operative and advantageous to this extent; but it would be less so than if it were used in the apparatus at each station. If condensers were placed at both stations in the required combination, signals at both could be more rapidly and perfectly received.

It admits of fair argument whether it would not have been a fair construction of the claim of the original to interpret it as meaning the combination of a condenser with the two relays of the duplex system. It would have been the duty of a court to construe the claim in such a way as to protect the real invention, unless the language of the specification and the claim would preclude such a construction.

The case does not turn solely on this point, however, because within eleven months from the granting of the original patent it was surrendered and a reissue granted which contained this claim: "Claim 2 is an apparatus for double transmission, the combination of a condenser with a branch or compensating circuit, whereby the effect of static induction upon the receiving relay or instrument is counteracted substantially as and for the purpose herein specified." The specification was amended by inserting as follows: "As the apparatus at each terminal station is similar, the diagram represents the apparatus at one station only." In this claim every unnecessary element of the combination is eliminated.

It covers the invention in the broadest form in which it can be stated. Limited as the terms must be by the descriptive matter of the specification, and read in view of the prior state of the art, the claim was not too broad. It does not require a condenser at each station as a constituent. In other respects, as is argued for the defendant, the claim is narrower in terms than that of the original, because it restricts the combination to one in which the condenser is employed with "a branch or compensating circuit." If this claim included as one of its constituents by fair interpretation "a condenser having its terminals respectively connected with said artificial lines and the earth," it was obviously broader than the claim which is now in controversy.

The claim in controversy is not enlarged by reason of an undue enlargement of the descriptive part of the specification of the reissue. Mr. Renwick, an expert for the defendant, in his affidavit says that he agreed with Mr. Palmer (another expert for the defendant) whose affidavit he has read, "that all the additional descriptive matter which describes more fully and completely the operation and uses of the condenser and the structure of the condenser is legitimate and although not necessary does not widen the invention described in the original patent." He goes on to say that the patentee enlarges his general preliminary statement of the character of his invention because in the original patent "he states in substance that the invention consists in placing a condenser in a certain branch circuit" while the reissue "states in substance that the invention consists in producing artificial currents of static charge and of static discharge at the home station and causing the same to occur simultaneously with those from or on the main line, and that therefore the effect of the latter can be practically eliminated." What the patentee does state in his original is this: "This invention is an improvement upon apparatus for transmitting two signals at the same time from opposite ends of the same line wire, its object being to prevent the effect upon the relay at the sending station of the return current due to the static induction of the line; and it consists in the connection with the apparatus of a condenser of any of the well-known forms." In the first reissue the statement is as follows: This invention relates to duplex telegraph apparatus its object being to neutralize the effect of the return current from the line on the relay or receiving instrument when the line is put to work; and to effect this the invention may in general, be stated to consist in the modes of accomplishing this result by establishing in a branch or compensating circuit connected to the circuit of the compensating helix of the relay, during the time that the line is put to work a return current which will neutralize the effect of the return current from the line upon the line-helix of the relay substantially in the manner hereinafter described." Mr. Renwick's criticism upon the preliminary statement of the nature of the invention contained in the second reissue is that no mention is made in it of a condenser and no assertion that the invention is based upon the use of a condenser, although it is stated afterwards that the result may be conveniently effected by the use of a condenser. Obviously this criticism has no force when applied to the claim in controversy because the claim makes the condenser an element of the combination.

A condenser having its terminals respectively connected with the artificial or compensating line of the combination is precisely what is described in the claim of the first reissue as a condenser,

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"with a branch or compensating circuit ....substantially as and for the purpose herein specified." The only distinction between the two things which is emphasized in the argument of counsel is that it substitutes "an artificial line" in place of a "branch circuit" or compensating circuit. It is entirely clear that these terms are used synonymously in the electrical art. The compensating circuit is commonly termed the artificial line. The specification states that the branch circuit "is technically called the artificial line in order to distinguish it from the main line." There is no merit in the criticism.

It thus appears that the claim of the second reissue now in controversy is not only no broader than claim 2 of the first reissue, but it is specifically narrower in terms although not so in effect when the specific elements required by construction to be incorporated were read into that claim and it also appears that the second claim of the first reissue was no broader than was warranted by the invention.

The claim in controversy is good notwithstanding other claims of the reissue expand the claim of the original patent or any claims which the patentee might have lawfully made. As to this claim the second reissue is valid if it is invalid as to the other claims, Gage *v.* Herring, 107 U. S., 640.

It protects the complainant if the first reissue was lawful and so much of the invention as was not claimed in the original was not abandoned to the public when that reissue was obtained. There has been no abandonment since the first reissue was granted.

The case then hinges upon the validity of that reissue. Was it a lawful exercise of authority on the part of the commissioner? Was the patentee entitled to reclaim so much of his invention as he had not claimed in the original? The test is found in the rule enunciated in Hahn *v.* Harwood, 112 U. S., 354. That decision covers two propositions applicable here. The first is that a patent cannot be lawfully reissued for the mere purpose of enlarging the claim unless there has been a clear mistake inadvertently committed in the wording of the claim, and the application for reissue is made within a reasonable short time. The second is that the question whether there has been such an inadvertent mistake is, in general, a matter of fact for the commissioner to decide; but whether the application is made in reasonable time is matter of law which the court may determine by comparing the reissued patents with the original, and if necessary with the records in the Patent Office when presented by the records. It was further decided in that case that no invariable rule can be laid down as to, what is a reasonable time within which the patentee must seek for the correction of a claim which he considers too narrow; that it is for the Court to judge in each case and it will exercise proper liberality towards the patentee; but as the law charges him with notice of what his patent contains, he will be held to reasonable diligence. In Coon *v.* Wilson, 113 U. S., 268, the reissue was applied for only a little over three months after the date of the original patent but it was held to be invalid because apparently made to enlarge the scope of the original when the circumstances rebutted any presumption of inadvertence or mistake in the wording of the claim of the original. It appeared that the claims of the reissue were enlarged in order to embrace articles made by the defendant subsequent to the date of the original and not covered by the claim, and it also appeared that what was sought for by the reissue was industriously excluded from the description in the original. This is not such a case.

The claim in the original patent was not one as to which it can be said that the patentee had no ground to suppose it to be narrower than his invention. It did not necessarily and unequivocally confine the patentee to a combination requiring a condenser in connection with the relay at each station. While that might be the interpretation which on first impression would be suggested to the mind of the patentee there was nevertheless room to contend for one which would give him all he was entitled to. Indeed it appears that the Patent Office was of the opinion that the patentee was restricted by the description and drawings to the use of a condenser at one station only. Nothing in the affidavits indicates that the reissue was applied for in view of any new apparatus or patent brought into existence intermediate his application and the date of the original. There was no motive for enlarging the claim which did not exist when he applied for the original patent. The only circumstance that is suggested to show that he did not intend to claim originally what he claimed in his application for a reissue is that shortly before he made his application for the original he had made an application which was withdrawn, which contained a claim as follows: "In a telegraph apparatus for double transmission operated as described a condenser in combination with the relay and resistance coil connected therewith for the purpose of preventing the effect of the return current due to the static charge of the line." In that application the preliminary statement of the nature of the invention and the descriptive parts of the specification differed in many respects from those substituted in the new application. It is apparent on the face of the claim, which makes a resistance coil (or rheostat) an element of the combination, that it was in this respect narrower than the claim in the new application. It was not limited by the words "at each station," but in other respects was a narrower claim. There was nothing in the language of the application to indicate that the patentee supposed his combination would not be operative if the condenser was employed at one station only or that his claim would be too broad unless limited as expressed.

In short there is nothing in the circumstances that he substituted a new application for one previously made to distinguish the transaction from the common one where an inventor is dissatisfied with the contents of his application and wishes to exercise his privilege of preparing and making a new one which shall more carefully and completely protect his rights. There is no fair reason for assuming that he deliberately intended to limit himself in the application which was acted on to a narrower claim than he was entitled to make.

The case is one where the patentee applied for a reissue within eleven months from the date of his original patent in order to correct a claim which might not fully secure his invention and which was certainly so ambiguous as to suggest a doubt whether it was sufficient or not. It is not a case where the suggestion of inadvertence or mistake was a mere prétense of the patentee or one where the mistake was so obvious as to be instantly discernible upon reading the claim. So far from being apparent upon the first inspection of the patent there is room for grave doubt now whether it was not sufficient. The patentee was justified in moving cautiously and saving himself unnecessary expense. The granting of the reissue so far from being an abuse of the power conferred upon the Commissioner was a just and equitable exercise of his authority. The patentee was not guilty of laches; his application was made within a reasonable time; and the reissue, so far at least as it relates to the second claim, was a legitimate and commendable exercise by the Commissioner of the duty devolved upon him by statute.

Although as to the claims in controversy the second reissue must be held valid that reissue in the form of three divisions, containing nine claims in all, was entirely unnecessary. The rights of the complainant were fully protected by the first reissue; the second must have been obtained upon the theory that the patent might be useful as a weapon of offense by means of claims so comprehensive and elastic as to embrace within their scope all subsequent inventions which might be made in the same field of improvement. Intermediate the time of the first reissue and the application for the second reissue, patents for cognate inventions were obtained by Thompson & Selden (September, 1879), by F. E. Jones (March, 1880), and by Gerritt Smith (March, 1881). The reissue in suit was apparently designed to overreach these patents and subordinate them to the complainant's monopoly. The reissue is not to be criticised because the claims of the several divisions cover the invention of Stearns in the broadest form and in the narrowest form in which it is capable of use, but because it is upon its face a flagrant attempt to enlarge the scope of the invention in order that the patent might be more available for the suppression of all competing inventions. It is well calculated to mislead the public into the belief that the complainant enjoys practically the exclusive control of duplex and quadruplex telegraphy as used over long lines. A party seeking the assistance of a court of equity to protect such a patent, appeals to the Court to be astute to discover a legal right which has not been subverted in the unjustifiable attempt to encroach upon the rights of others. A complainant asking the protection of such a patent does not occupy an attitude which is commendable in the view of a court of equity. If the essential motive of those who represented the complainant in obtaining the reissue, was to enable the complainant to assert a colorable title to an invention to which all subsequent inventors must pay tribute, this was an illegitimate and oppressive motive, and the Court should not be eager to come to their assistance when their patent is assailed, by granting them a remedy preliminary to final hearing. As was said by Lord Eldon, in Rundell *vs.* Murray, 4 Jac., 311. "Not only conduct with the party with whom the contest exists, but conduct with others, may influence the Court in the exercise of its equitable jurisdiction by injunction."

This remark was cited with approval by Lord Cottenham in Landers *v.* Smith, 3 My. and Cr. 711,730. The patent as reissued is well calculated to suggest doubts as to its validity, and lead those who examine it to suppose that such an abuse of the statutory privileges cannot be tolerated. The officers of the complainant have only themselves to blame if others had acted on the assumption that the patent cannot stand. The defendant has acted upon this belief. Under such circumstances the complainant should not have the stringent remedy applied for, and it is not only within the fair discretion, but it is the duty of the Court to deny preliminary relief, and leave the complainant to the ordinary relief at final hearing.

IMPORTANT ELECTRIC LIGHT CONSOLIDATION.

The American Electric Manufacturing Co. has secured the control of the Fuller-Wood system of electric lighting with the new five-story factory on West 18th street, which is said to be one of the best and most thoroughly equipped establishments for the

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manufacture of electric lighting apparatus in the country, the machinery being new and of the most approved pattern. The papers have been executed between president William H. Appleton, of the Fuller-Wood company, and president Edward H. Goff, of the American company, by which the latter company secured possession of the property of the former corporation. Prof. Wood's improvements and latest inventions are said to be of great value, and when put into practical use will supersede all of the old Fuller patents, and make the system a most complete and economical one in cost of construction and operation. The contract which has been signed carries these with it.

The alliance recently made with the Edison company and this action of the American company, by which both corporations labor with one another in introducing their systems, will enable it to compete successfully with any gas or electric company.

In a recent interview, president Goff was questioned as to the action of the American company in abandoning the Thomson-Houston system, which he had labored so long and earnestly to establish. He declared he had nothing against the Thomson-Houston system. He thought it was for the advantage of his company to take hold of the new system. In the first place it was as profitable to operate, and fully as economical to build, as any other system. Next, it would enable the American companies to be independent of all other companies and to derive the entire profits from the manufacture and sale of the apparatus. The New York factory he expected to run to its fullest capacity in the manufacture of dynamo machines, and that the lamps would in all probability be made by the Electrical Development and Manufacturing Co., of Boston. The American company claims to have orders now on hand for over $200,000 worth of new apparatus.

THE EDISON INCANDESCENT SYSTEM.

Incandescent lighting from central stations, is making steady progress as will be learned from the following list of plants established by the Edison company.

Name of City or Town.	State	Capacity of Machinery.	Lamps Suppl'd
Berlin	Germany	14,000	......
Milan	Italy	8,000	......
New York	New York	8,000	1,300
Bellefonte	Pennsylvania	800	1,200
Middletown	Ohio	500	700
Williamsport	Pennsylvania	3,200	4,500
Piqua	Ohio	1,000	1,200
Newburgh	New York	2,400	3,000
Tiffin	Ohio	1,000	1,200
Fall River	Massachusetts	2,400	3,000
Hazleton	Pennsylvania	1,000	1,200
Lawrence	Massachusetts	3,200	4,500
Shamokin	Pennsylvania	2,400	3,000
Brockton	Massachusetts	2,400	3,000
Circleville	Ohio	1,050	1,200
Cumberland	Maryland	1,000	1,200
Des Moines	Iowa	1,600	2,000
Appleton	Wisconsin	500	2,000
Harrisburg	Pennsylvania	4,800	5,000
Westchester	Pennsylvania	1,600	2,000
Johnstown	Pennsylvania	1,000	1,200
Tamaqua	Pennsylvania	1,600	2,000
McKeesport	Pennsylvania	1,600	2,000
New Brunswick	New Jersey	1,600	2,000
Boone	Iowa	600	1,000
Wilmington	Delaware	1,600	2,000
		68,850	51,400

The following classification of isolated plants will be found of special interest, as showing the various lines of business which have found it advisable to adopt private incandescent lighting.

PLANTS ESTABLISHED FOR AND OWNED BY PRIVATE USERS.

	Plants.	*Lamps.*
Educational institutions, public asylums, and hospitals	26	7,173
Hotels, apartment houses, and club rooms	23	11,035
Theatres and places for amusement	20	14,033
Banks, office buildings, stores, residences, &c,	73	23,757
Newspaper and other printing offices	30	6,521
Sugar refineries	11	4,864
Flour mills and grain elevators	26	1,934
Cotton, woolen, and textile fabric mills	81	25,898
Pulp and paper mills	30	3,318
Oil refineries, distilleries, dye houses, chemical works, and meat-packing houses	29	8,392
Water works, rubber factories, and miscellaneous manufacturing establishments	39	5,088
Iron works, car and machine shops	40	7,828
Furniture and pianoforte manufactories and wood-working establishments	15	2,360
Steamships, steamers, yachts, &c.	51	8,092
Grand totals	494	125,293

This makes a grand total of 177,000. Or, if the lamps actually placed in isolated plants were taken instead of merely the dynamo capacity, a grand total of upward of a quarter of a million Edison lamps in actual use in this country alone.

AN INCANDESCENT LAMP FOR LIGHTHOUSES.

A Washington despatch says that Major David Porter Heap, engineer-secretary of the Lighthouse Board, has perfected a new arrangement of the electric light in its application to lighthouses which promises to be of great services in the time of fogs. This discovery of his he proposes to give to the government.

He early saw grave objections to the use of the arc light, the principal one being that it penetrated fog but little more than other and feebler lights now in use. His conclusions in this respect have recently been verified by the experiments at South Foreland, England, made by the Trinity House, where it was shown that a 15,000 c. p. electric light penetrated fog very little further than an oil or gas light of 2,500 c. p. The reason of this is that the arc light is mainly composed of rays towards the violet end of the spectrum, while oil light is composed of rays towards the red end, and these latter rays are the most fog-penetrating.

What is needed most for lighthouse purposes is a very powerful light, rich in red and yellow rays. This latter condition is fulfilled in the incandescent lamp, but unfortunately those so far constructed are of but small candle power, the brightest so far made not much exceeding 150 candles. Major Heap believes that this power can be greatly increased, and as a step to this end has invented and intends to try experimentally a lamp constructed as follows:

The size of the flame of a third-order oil light is a cylinder $1\frac{3}{4}$ inches high and $1\frac{5}{8}$ inches in diameter, and the lens containing this light is constructed to give the best results from this sized flame. Now suppose two discs of carbon, each $1\frac{5}{8}$ inches in diameter, one placed $1\frac{3}{4}$ inches above the other and connected to each other by 24 carbon filaments $\frac{1}{5}$ of an inch apart attached to their peripheries, and the whole inclosed in an air-tight glass bulb, through which pass wires from each carbon disc to the source of electricity. If it be assumed that each filament can give 15 c. p., which is not an extravagant estimate, the 24 filaments should give 360 c. p., and this would raise third-order lenses to nearly an equality to the present first-order, which contain lamps of 420 c. p. Should experiment show that the above assumptions are correct, a larger incandescent lamp could be made to be used in a first order lens, which calculations show should exceed 1,000 c. p.

The incandescent lamp possesses various other advantages for lighthouse illumination which it is unnecessary to touch upon until its power can be sufficiently raised to make it an efficient light.

ESTATE OF FREDERICK A. GOWER.

Lilian Norton-Gower, known professionally as Lilian Nordica, the prima donna, has gone to Paris to claim the estate of her husband, Frederick A. Gower, who is supposed to have been lost from a balloon, as nothing has been heard of him or of the balloon since the ascension was made from Cherbourg in July. His estate is valued at $3,000,000. He made his fortune largely in the telephone, which he went to Paris some years ago to introduce into Europe soon after the successful experiments of Prof. Bell in this country. He was formerly a journalist in Providence, R. I., and as an associate of Prof. Bell lectured on the telephone before he went abroad. Mrs. Norton-Gower some time ago petitioned the court for a separate maintenance from her husband, praying that she be freed from his control on the ground of ill treatment. She said she was a native of Maine, and married Mr. Gower in Paris about 15 or 16 months ago. Mr. Gower asked for a postponement in presenting his evidence to enable him to return to Paris. He made the ascension to continue experiments to test the use of balloons for war purposes.

BEGINNING UNDERGROUND WORK IN DETROIT.

In August last the Dorsett Underground Service Company was organized in Detroit with a capital of $500.000 for the purpose of constructing a system of underground conduits like that which has been used in Chicago for a year past. Mr. Hugh McMillan is president, and the Michigan Telephone Company is represented by two out of a board of five directors.

Before granting the ordinance for a thirty-year franchise, a committee of the Detroit common council visited Chicago and subsequently rendered the following report:

To the Honorable the Board of Councilmen:

Gentlemen—Your committee on streets and ordinances, to whom was referred the ordinance for the construction and maintenance of the Dorsett conduit system, would respectfully report:

That the matter has had our careful and personal examination.

That owing to the fact that it was an important matter, your committee deemed it advisable to visit Chicago for the purpose of examining the system in practical operation, which your committee did, and are pleased to report that we found upwards of ten miles of conduit constructed by Mr. Dorsett in full operation in the city of Chicago, and that the material used in the construction of the conduit was of such a character as to render the conduit absolutely impervious to water, air or gas. From the examination made, your committee are of the opinion that it is the most perfect system now in existence, and therefore recommend its adoption by your honorable body.

Respectfully,
RALPH PHELPS, JR.,
E. P. CONAHAN,
AUGUST GOEBEL,
THOMAS M'GRATH,
THEO. RENTZ.

Accepted. The ordinance was read twice by its title, and by unanimous consent placed upon the order of third reading and unanimously adopted.

There is to be put down before December 1st six miles of

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double conduit with the laterals, one tube of seven ducts for telegraph and telephone, another of the same size for electric light wires. Those of the Michigan Telephone Company will be placed in the conduit upon its completion, and applications have been made for accommodating electric light wires. The construction of the conduit has already been started.

INFRINGEMENT OF INSULATED WIRE PATENT.

A notice has been issued by the Ansonia Brass and Copper Company and Holmes, Booth and Haydens that suits will be brought against all persons using or dealing in insulated wire not made by them, or the American Electrical Works, which infringes the claims of A. A. Cowles's patent No. 272,660, as follows:

1. The method herein specified, of insulating Electric Conductors, and rendering the coating substantially non-combustible, consisting in applying a layer of fibrous material, a layer of paint, and a second layer of fibrous material upon the paint before it dries or sets, substantially as set forth.

2. An insulated and non-combustible covering for Electric Conductors, composed of two or more layers of cotton, or similar threads, with paint that intervenes between the layers and fills the interstices of the covering, substantially as set forth.

THE TELEGRAPH.

A report comes from Harrisburg to the effect that the Standard Oil Co. is about to engage in the general telegraph business.

The Baltimore police department is introducing a call-box system similar to that now used in Chicago, St. Louis and Washington. Both telegraph and telephone will be employed in connection with it.

The lodging of kite-tails on the police and fire telegraph wires in New York city, has led to the enforcement of an existing law which imposes a penalty of $5 for flying kites below 14th street

Sheriff Dewstoe, of Cleveland, O., has issued attachments on all the property of the Postal Telegraph Co. in 12 counties of the state, on a judgment against the company for $42,000 in favor of Campbell C. Brown and Thomas Fleming, holders of two promissory notes which were not paid at maturity.

ELECTRIC LIGHT AND POWER.

Domestic.

W. R. Anno, N. L. Mills, Nat. Poyntz, T. J. Shine and J. B. Paramore have organized at Orlando, Fla., the Orlando Gas and Electric Light Co., capital stock, $50,000, to establish gas and electric light works.

The Menomonie (Wis.) Illuminating Co. has filed articles of association, the object being to furnish electric light to the city of Menomonie. The capital stock is $15,000, and the incorporators are H. E. Knapp, E. Marks, S. B. French, and J. D. Hills.

The Chicago Electric Railway Co., at Chicago, has been incorporated, capital stock $10,000, for the construction of railways and tramways upon which electricity may be used as a motive power; incorporators, Wm. G. McCormick, David G. Hamilton and S. E. Stanley.

The Rockford (Ill.) Electric Light Co. has just closed a contract with the Western Edison Electric Co. of Chicago for 1,200 10 c. p. lamps. The capital stock of the company has been increased from $20,000 to $50,000. A proposition has been made to light the city which it is thought will be accepted.

The Edison company has fitted up 51 vessels with a total number of 8,092 incandescent lamps. The largest single installation is that of the steamer *Pilgrim*, numbering 920.

Foreign.

Among the awards at the Inventions Exhibition, London, were gold medals for the Edison-Swan systems of electric lighting and the Thomson-Houston; silver medal, the Bernstein incandescent lamp.

Machinery is now in readiness to illuminate Dufferin terrace in Quebec, by electricity generated by water power at Montmorency Falls, over a circuit 34 miles in length.

PERSONAL MENTION.

Thomas D. Lockwood, of the American Bell Telephone Co., will lecture on the telegraph and telephone, next winter, before the Lowell Institute, of Boston.

THE TELEPHONE.

The Charleston (S. C.) telephone exchange property was damaged to the amount of about $4,000 by a recent tornado.

A large proportion of rural exchange subscribers in New England are discontinuing the service in consequence of the recent increase in rates.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions,* 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From August 18th to September 15th, 1885 (inclusive).

Alarms and Signals:—*Annunciator*, R. Edwards, 324,869, Aug. 18; H. E. Waite, 325,463, Sept. 1. *Indicator*, M. Bacon, 324,635, Aug. 18. *Alarm* J. J. Wood, 325,639, Sept. 1. *Sewer*, J. H. Clark, 325,820, Sept. 8. *Shallow Water Indicator*, F. E. Forster, 326,028, Sept. 8. *Signaling Apparatus*, F. G. Sargent, 326,158, Sept. 15.

Clocks:—*Impulsion Device for Torsion Pendulum*, H. Rabe, 325,118, Aug. 25. *Clock*, F. R. Field, 324,824.

Commutators:—*Circuit Closer*, A. T. Smith, 325,124, Aug. 25.

Conductors, Insulators, Supports and Systems:—*Terminal for Electric Light Cables*, W. R. Patterson, 324,413, Aug. 18. *Method of Temporary Electric Lighting*, L. Goldenberg, 324,551, Aug. 18. *Insulator*, G. W. Hill, 324,692; J. D. Putnam, 324,957, Aug. 25. *Conduit for Cable and Electric Railways*, I. W. Heysinger, 325,173, Aug. 25. *Circuit for Electric Lighting*, H. P. Brown, 325,389, Sept. 1. *Arc and Incandescent System*, 325,390. *Incandescent System*, same, 325,391. *Underground Conductor*, D. Brooks, 325,495 *Socket and Connection for Lighting Circuits*, G. Hess, 325,540. *Insulating and Anti-Induction Tube for Conductors*, F. B. Rae, 325,630. *Machine for Covering Wire*, V. & J. Royle, 325,363. *Combined Track Support and Conduit*, J. H. Gould, 325,531. *Method of Laying Wires*, W. D. Smith, 325,984, Sept. 8. *Supporting Wires*, M. Heltinger, 325,743. *Die for Covering Wire*, G. M. Cruickshank, 326,021. *Method of Applying Balata Insulation*, P. C. Matherson, 326,132, Sept. 15.

Dynamo Machines and Motors:—*Regulator for Dynamos*, E. Thomson, 324,501, Aug. 18; P. Diehl, 324,666; R. H. Mather, 324,862, Aug. 25. C. J. Van De Poele, 325,133. *Current Regulator for*, J. A. Lannert, 324,566, Aug. 18. *Commutator Brush for*, J. A. Powers, 324,590. *Dynamo Machine*, H. Cushman and J. P. Hall, 324,752; C. L. F. Mueller, 325,619, Sept. 1. *Motors*, P. Diehl, 324,667, Aug. 18; L. G. Woolley, 325,641, Sept. 1. F. J. Sprague, 324,891, Aug. 25. *Armature for Dynamos, and Motors*, S. F. Van Choate, 325,714, Sept. 8. *Automatic Stop Apparatus for Motors Driving Dynamos*, O. F. Jönsson, 326,223, Sept. 15.

Galvanic Batteries:—*Connector for Batteries*, G. Otto, 324,410, Aug. 18. *Galvanic Battery*, W. T. Lyman, 324,475; E. F. Leighton, 324,708; J. B. Low 324,858, Aug. 25; E. G. Hammer, 326,033, Sept. 8.

Ignition:—*Gas Engine*, C. W. Baldwin, 325,378, Sept. 1. *Gas Lighter*, F. H. Root, 325,569.

Lamps and Appurtenances:—*Holder for Incandescent Lamps*, F. M. Brown, 324,580, Aug. 18. *Arc Lamp*, O. P. Loomis, 324,778; A. B. Worth, 324,793; E. Thomson, 324,502, A. H. Bowman, 324,798, N. McCarty, 325,423, 325,424, Sept. 1. Geo. M. Hopkins, 325,802, Sept. 8; R. F. Jones, 326,123, Sept. 15; J. Du Shane, 326,487. *Socket for Incandescent Lamps*, W. Stanley, Jr., 324,894, Aug. 25. *Alternating Switch for Incandescent Lamps*, J. A. Cabot, 324,979. *Safety Device for*, same, 324,980. *Process of Making Incandescents*, same, 324,981. *Manufacture of Incandescents*, P. N. Mackay, 325,257, Sept. 1. *Incandescent Lamp*, O. A. Moses, 325,958, Sept. 8, *Lamp Hanger*, W. S. Weston, 326,363, 326,364, Sept. 15. *Bulb Case for Incandescent Lamps*, S. H. Sprague, 326,459. *Arch for Supporting Lamps*, P. H. Griffin, 326,498.

Measurement:—*Meters*, W. G. Price, 325,011, Aug. 25; C. J. Van De Poele, 325,225. *Apparatus for Testing Circuits*, I. H. Farnham, 325,520, Sept. 1.

Metallurgy:—*Process of Smelting Ores*, E. H. and A. H. Cowles, 324,658, Aug. 18. *Process of Smelting for Obtaining Aluminum*, same, 324,659.

Miscellaneous:—*Type Writer*, J. R. Murphy, 324,407, Aug. 18. *Hydrostatic Testing Machine*, W. R. Patterson, 324,412 .*Elevator*, S. S. Wheeler, 324,621, Aug. 18. *Contact Point*, E. T. Gilliland, 324,678. *Electric Belt*, O. F. Main, 324,713, L. Hughes, 325,086, Aug. 25. *Safety Device for Elevators*, R. M. Curtiss, 324,751, Aug. 18. *Automatic Specific Gravity Apparatus*, G. A. Bobrick, 324,808, Aug. 25. *Regulator*, W. Stanley Jr., 325,576, Sept. 1. *Switch Plug*, J. H. Bunnell, 325,653, Sept. 8. *Process of Making Plates of Carbon*, S. J. Coxeter and H. Nehmer, 325,822. *Electro-Magnetic Log*, L. B. Favor and C. A. Jacobs, 326,207, Sept. 15. *Induction Coil*, W. Burnley, 326,270. *Electrical Apparatus for Controlling Marine Engines*. L. M. Sanders, 326,337. *Organ Action*, G. G. Wacker, 326,359. *Safe*, O. Gassett, 326,424.

Railways and Appliances:—*Telegraph*, E. B. Ives and C. W. Williams, 324,381, Aug. 18. *Apparatus for Propelling Vehicles*, F. Wynne, 324,447, Aug. 18. *Car Brake*, E. B. Hess, 324,470, C. E. Jones, 324,774. *Railway Controlling System*, C. A. Mayrhofer, 324,476. *Motor*, F. J. Sprague, 324,892, Aug. 25. *Railway*, C. J. Van De Poele, 324,899, Aug. 25. *Conductor for*, John Hopkinson, 325,063, J. Perry and W. E. Ayrton, 326,237, Sept. 15. *Lighting Railway Cars*, H. E. Freese, 325,795, Sept. 8. *Locomotive*, L. Daft, 325,915. *Signal*, I. A. Tivamis and C. C. S. Currie, 326,068.

Storage Batteries:—J. S. Sellon, 324,597, Aug. 18; 325,120, Aug. 25.

Telegraphs:—*Cut-out*, C. H. Lothrop, 324,711, Aug. 18. *Magneto-Electric Telegraphy*, F. H. Brown, 324,746. *Telegraphy*, W. E. Athearn, 324,799, Aug. 25. *Printing Telegraph*, R. J. Sheehy, 325,702, Sept. 8. *Controlling Press Circuits of Printing Telegraphs*, C. L. Healy, 326,084.

Telephone Systems and Apparatus:—*Acoustic Telephone*, W. T. Black, 324,356, Aug. 18; J. B. Cleaver, 325,500, Sept. 1; H. Seligman, 326,458, Sept. 15. *Telephone Switch*, J. A. Cabot, 324,358, Aug. 18. *Telephone System*, C. W. Price and A. Barrett, 324,591, A. E. Dolbear, 325,659, Sept. 8. *Transmitter and Relay*, T. J. Perrin, 324,726, 324,727, Aug. 18. *Transmitting Apparatus*, 324,728. *Transmitter*, T. J. Perrin, 324,729, W. Burnley, 326,269, Sept. 15. *Means for Increasing the Efficiency of Telephones*, A. E. Dolbear, 325,660, Sept. 8. *Telephone Repeater*, M. G. Farmer, 325,920. *Switch-Board Plug*, C. K. Mead, 325,952. *Receiver*, W. Burnley, 326,268, Sept. 15.

Expired Patents.—A list of the more important electrical patents which expired during the month of September, 1885, together with those which will expire during the present month is subjoined:—P. A. J. Dujardin, *Printing Telegraph*, 82,502; reissue 7,627, Sept. 29.—A. Barbarin, *Gas-lighting Apparatus*, 81,785, Sept. 1.—R. B. Boyle, *Printing Telegraph*, 81,871, Sept. 8.—E. Beach, *Torpedo for Oil-Wells*, 82,586, Sept. 29.—L. H. Reynolds. *Self-Adjusting Relay*, 82,629, Sept. 29.—S. F. Day, *Telegraph Instrument*, 82,695, Oct. 6.—S. C. Bishop, *Insulating Compound*, 83,031, Oct. 13.—G. M. Thompson, *Wire-Stretcher*, 83,109, Oct. 13.

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Conducted by F. L. POPE. R. W. POPE, Associate Editor.

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NEW YORK, NOVEMBER, 1885.

WAITING FOR THE VERDICT.

THE ultimate day has arrived, when, according to the original Daly bill, all wires, wherever found overhead in cities of 500,000 inhabitants or upwards in the state of New York, were to be removed and placed underground by the authority of the state. At the time the interest awakened in this discussion was greatest, we ventured the prediction that on the first day of November, 1885, there would be more wires overhead than existed at the time of writing. Such is notoriously the case, yet the date mentioned marks a certain amount of progress. Official investigation on the part of the commissioners appointed to enforce the law, has in every particular confirmed the assertions previously made by electrical experts, that there were serious difficulties to be encountered, and that strict compliance with the original act would at a blow deprive the business and resident public of the facilities for electrical communication which they have long enjoyed.

The arbitrary provisions of the bill which aroused so great an opposition from the various companies interested, as well as from the electrical press, was materially modified by the subsequent act of June 15th, 1885, by which the commissioners are allowed to exercise their discretion in compelling the adoption of subterranean routes, and the solitary subscriber, who has no telephonic neighbor within 18 blocks, may not be called upon to bear the expense of either constructing or paying rental for a mile or more of conduit constructed for his special benefit.

The popular idea of placing wires underground according to the teachings of the daily press, is simply to take them off the poles, tie them in convenient bundles and bury them at the bottom of a ditch. A similar view of the problem was taken by at least two of the inventors who submitted underground plans to the commission. This is by no means an enlightened view of the situation, as progress is desired above all things, and the electrical condition of aerial wires in New York city to-day is by no means as satisfactory as might be inferred from the opposition of the various companies toward the enforcement of the underground law. They act simply upon the familiar maxim that it is "better to bear the ills we have, than fly to others we know not of." The first subterranean work undertaken some ten years ago by the Western Union company was done voluntarily, in the confident belief that a system of that character would be exempt from the well-known evils which attend aerial electrical communication in densely populated districts. Advantage was taken of European experience in the same line, and while the results have by no means been entirely satisfactory, it is far from the truth to assert, as has been more than once done, that these experiments were made merely to prove that wires could not be successfully operated underground. It will no doubt be admitted that the recent sessions of the New York commission on electrical subways afforded an opportunity for every plan to be presented, and the substantial reward awaiting the successful competitor is no doubt sufficient to bring out the best existing ideas on the subject, yet not a single system was presented which did not have its defects. Of course very many of them were wholly impracticable, either from a mechanical, electrical or financial standpoint, while others might perhaps serve the purpose more or less well but had not received practical endorsement. A large proportion of the plans proposed did not in fact come under the provisions of the law, and might without impropriety have been ruled out altogether.

A gentleman who has given this subject very thorough study for several years, informed the commission that a conduit was merely a hole through the ground, while the *New York Times*, which has perhaps been the foremost advocate of underground schemes, declared editorially a few days since that "nothing is more unreliable than a hole in the ground."

None can be more thoroughly aware of the defects and weaknesses of existing electrical systems than those who have had the greatest experience with them. Knowing the difficulties of maintaining the electric service at a high point of efficiency under its present conditions, they do not feel disposed to admit that any plan is perfect which they have not personally tested, although it may prove better adapted to their purpose than they suppose. An experienced spiritual expert once ventured the opinion that no whiskey was absolutely bad, although undoubtedly some brands of whiskey were not so good as others. By the same line of reasoning it may well be argued that no subterranean system is good, although some plans are worse than others.

October 15th, 1885 was the last day for the filing of plans with the Board, and those which were received before the adjournment are to be examined in executive session and finally passed upon.

Such being the condition of affairs; the evidence all in, and under consideration, advice and criticism may properly be reserved until a verdict has been given. From the very nature of the case there will be disappointment and unjust accusations, but if the commissioners give their decis-

ion in accordance with what has practically proved the best, so far as they can ascertain, they will have at least performed their duty, and may well content themselves by the reflection, that despairing of any light from the conflicting theories of the various inventors and promoters, they fell back upon their own judgment, and in accordance with the law and the evidence, decided how in their opinion, a hole in the ground could be most economically made and effectually maintained, without detriment to the existing electrical service, while at the same time giving due consideration to future growth.

THE GOVERNMENT AND THE TELEPHONE PATENTS.

Referring to the proceedings instituted by certain law officers of the government for annulling the Bell patent, we said last month that the personal interests of attorney-general Garland were so clearly of a character to profit by the successful issue of such an action that an immediate and complete explanation on the part of that official appeared to be necessary. A few days afterwards the explanation appeared in the form of a letter, addressed by the attorney-general to the president, and given to the press, the substance of his statement being that he had no personal knowledge of the action which had been taken; it appearing that the application was in fact made to solicitor-general Goode, and the request was granted by him in the absence of the attorney-general. The attorney-general further explains that the solicitor-general is not a deputy or agent, but acts by the authority of a commission directly from the people through the president; that he is not therefore responsible to the attorney-general, nor can the latter exercise any control over his discretion. In reference to an inquiry by the president as to the ordinary course of procedure in such cases, the attorney-general admits that it has been the practice to first refer all such questions to the department from which the original transaction emanated. Accompanying this document was a letter from president Cleveland to solicitor-general Goode, accompanying the statement of attorney-general Garland, and somewhat pointedly calling his attention to the fact that the reference to the Interior department as an ordinary feature of the procedure, seemed to have been dispensed with in the treatment of this application, and suggesting whether such action as will preserve such precedent and custom might not well be taken. In reply to this communication the solicitor-general explains that his reason for granting the application without the usual reference to the Interior department was the result of "a satisfactory persuasion derived entirely from the papers" presented to him "as to what was right and proper to be done in the premises." The papers appear to have consisted of affidavits furnished by district attorney McCorry, and a certified copy of the proceedings in the patent office in relation to the issue of the Bell patent, which papers, he says, seemed to contain all the necessary information. Nevertheless, the solicitor-general states in conclusion, that he has directed district attorney McCorry to discontinue the suit. Thus ended the first chapter of the history of this peculiar case. The explanation of the attorney-general, while perhaps technically sufficient, is not altogether satisfactory, but it is far more so than the explanation of solicitor-general Goode. If, as his letter states, he had given the papers a careful examination, it surely ought not to have escaped his notice that the most important allegation of the bill, viz.: that Bell had altered his pending application in consequence of having fraudulently obtained a knowledge of the contents of papers filed by a rival inventor, was absolutely false. The remarkable haste which was exhibited in granting leave to district attorney McCorry to institute the suit, which, if we are rightly informed, was the very next day after the application was made, seems to indicate that there may have been some peculiar reason for the unusual zeal of the solicitor-general.

No sooner, however, had the original suit been discontinued as above noted, when district attorney McCorry again applied to the department of justice for permission to bring a new suit in the name of the government to test the validity of the Bell patent, which application has, it appears, been referred to the commissioner of patents for the purpose of obtaining his opinion as to whether the proposed proceedings were justifiable. As the attorney of the Pan-Electric Telephone Company is said to be in attendance at Washington, it is probable that the commissioner will not be deprived of any assistance he may need in making the examination. It appears, furthermore, that the Globe Telephone Company of New York has filed a petition for the commencement of another similar suit by the government against the Bell patents, which has also been referred to the commissioner of patents.

The present indications are that the whole matter will ultimately become a partisan political issue. It is rumored that the political opponents of the attorney-general propose to examine the transaction whereby he received a million and a half of telephone stock while acting as a United States senator, and at the time of writing it seems not unlikely that an attempt will be made to investigate the whole business by means of a congressional committee.

It is believed by many that the original suit had no other object than to afford a plausible pretext for the refusal or postponement of injunctions which might be applied for by the American Bell Telephone company in the United States district courts against alleged infringers, claiming to act under the authority of the Pan-Electric Telephone Company. In the Baltimore case to which we alluded last month, this course of procedure seems nevertheless to have proved ineffective, and in fact we do not see how the decision of the court could well have been otherwise, for if such a precedent were once admitted, we should soon have the federal courts overrun by suits in which the United States would practically be both plaintiff and defendant, and it would be in effect impossible for patentees to secure any adequate protection against even the grossest infringements.

LOCAL TELEGRAPHY IN NEW YORK CITY.

The president of the Western Union Telegraph Company in a recent statement, frankly admitted that the local telegraph service in London was superior to that of New York, and furthermore announced that in his opinion the latter might be improved. Although no reason was given why this most desirable consummation cannot be reached, it may

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fairly be presumed that it is because it does not pay. Branch offices are established for the purpose of securing out-of-town rather than strictly local business, and as no additional rate is charged from these offices the expense of performing the service is increased by the necessary re-transmission of the telegram.

It is well understood by those who are familiar with telegraph business either professionally or as patrons, that communication with distant commercial centres is much more prompt than between points within the city limits. There are a number of reasons for this apparently anomalous condition of affairs. President Green gave but one, which was that there were in some cases eight or ten offices on one wire, and a message might be delayed by the operator waiting for his turn. He might have truthfully added that with a better class of operators, the time of waiting might be materially reduced. This however is a characteristic feature of the modern telegraphic system, which according to other eminent authorities is a vast training school, from which the graduated experts are continually being drafted into other fields which are believed to offer greater inducements by reason of their placing a higher value on experience.

No city in America offers such inducements for intercommunication as New York. The local postal service with an army of carriers, each of whom receives a salary equivalent to that of a good Morse operator, pays a handsome revenue, although it was not established "for revenue only," but as a desirable adjunct to the general postal service. Private letter-carrying establishments also carried on a prosperous business in competition with the government until suppressed by law. At least four district telegraph companies are engaged in a similar line of business. As to their profits we confess our ignorance, but in this particular branch it is patent to everybody, competition has not by any means developed an improved service. The telephone has also found ample room to build up an immense business in the local field, and while this agency is criticised because of the high prices charged for its use, we have no doubt that most of its subscribers save in car-fare, messenger hire and postage, a considerably greater amount of cash than they pay for its use. The elevated railways, and their new rival the Broadway line of horse-cars, are also no small factors of progress in local intercommunication. Amidst all these changes local telegraphy, even if it has been improved, which we are not prepared to admit, has by no means reached that state of perfection which can at least be imagined. This is a field which might not only be developed in itself, but would gradually familiarize the people with the use of the wires, and thus popularize the whole service. If this branch of the business was put in the hands of a wide-awake, intelligent, progressive telegrapher, familiar with the public requirements, and with authority to locate offices, engage competent operators, and advertise thoroughly, it appears to us that it would prove directly and indirectly a profitable department of this business. As it exists to-day it is practically a delusion and a snare. A fee of ten or fifteen cents is accepted for a service that in speed is inferior to that of the slowest messenger on foot, while the amount charged is so insignificant that a customer prefers to lose it rather than undertake to have it refunded in case of unreasonable delay. The local service necessarily costs as much, if not more than the long line service, and it is probably useless to try to perform it at a cheaper rate. Any reasonable rate would be cheerfully paid if the service were what it should and might be made.

This is a field however, to which the pneumatic tube system is more properly adapted, but to make it sufficiently comprehensive to meet the demands of the public in every part of the city, would incur an outlay for plant which no capitalist would care to risk. The tubes now used are merely auxiliary to the telegraph service, and are intended rather as feeders for the main office than for local intercommunication.

THE FINANCIAL RESULTS OF TELEGRAPHIC COMPETITION.

The annual report of the Western Union Telegraph Company, which we publish in another column, shows that its competitors are making formidable inroads upon its revenues. The report states that the profits for the fiscal year just closed, from which a dividend on $80,000,000 is to be paid, were actually less than in 1880, when the capital stock was only $41,000,000 ; the precise figures being $5,700,924.13 as against $5,833,937.79, although the actual number of messages transmitted had increased 44.3 per cent. and the mileage of wire no less than 98.2 per cent. The natural growth of the business transacted by the company has been very seriously interfered with by the competition of the past three years. For instance, the increase in the number of messages handled over the previous year, was in 1882, 6,342,000; and in 1883, 2,340,000; in 1884, 895,000, and in 1885, only 20,357. From these figures it seems certain that at the present rate of decline in its revenues, the Western Union must within a short time materially lower its rate of dividends, especially as the report indicates that the amount of money ordinarily spent for reconstruction, repairs and maintenance, has been largely curtailed, although the amount thus saved must necessarily be expended within a few years. As matters are going on at present, there is very little profit for anybody in the telegraphic business, but a change of some kind must inevitably be brought about at no distant day. We venture to express the prediction that the ultimate outcome of the present unsatisfactory situation, will be some sort of a pooling agreement based either upon the gross receipts, or the number of telegrams transmitted by the respective companies. Such a programme would obviously be to the advantage of the Baltimore and Ohio, but it is not altogether clear how the old company, under existing conditions, can manage to bring about any other arrangement which would be more favorable to its own interests.

The loss of revenue occasioned by the leasing of wires to parties who had previously been large patrons in the ordinary manner, is a significant feature in the report. It appears strange that little profit is derived from this source, as the cost of construction and maintenance of such wires is so well known, and was doubtless fully considered when the rental prices were fixed. Having in mind the many economies which have been practiced in order to maintain the financial standing of the company, and also that the increase of business from lower rates is not sufficient to encourage their further reduction, it certainly appears that the limit of healthy competition has actually been passed.

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ARTICLES.

ELECTRIC TRAMCARS.[1]

BY A. RECKENZAUN.

It may be premature to read a paper on the subject of electric tramcars, considering that at this moment there is only one such car in existence in this country, so far as the author is aware. This solitary example has, moreover, only been in operation experimentally since October last. It was with considerable hesitation, therefore, that this paper was prepared at the invitation of the council of this institute. The Inventors' Institute has, nevertheless, the privilege before other societies in this respect, that it will judge of the merits of an invention as an invention, apart from the commercial aspect of the problem. Utility, however, is the first desideratum in an invention, and the author now merely submits to this institute the bare question of utility. Before going into the details of our subject, it may be interesting to dwell for a moment upon the figures in the table below, which was prepared in order to show what power a pair of horses are capable of exerting. The power exerted in propelling a 46-passenger car, tractive force 30 lbs. per ton, two horses pulling 4.5 tons, is at—

		Horse-power.
7 miles per hour on level road		2.52
6 " " " "		2.16
6 " " on a gradient of	1 in 75	4.32
5 " " " " "	1 " 37	5.4
4 " " " " "	1 " 37	4.32
3 " " " " "	1 " 25	4.32
4 " " " " "	1 " 25	5.76
5 " " " " "	1 " 25	7.2
3 " " " " "	1 " 18	5.4

The additional power necessary to pull a car round curves cannot be ascertained with equal accuracy; it depends upon the radius of the curve, the amount of play in the axle boxes, and the size of the wheel flanges; a flexible wheel base will considerably facilitate the movement on curved roads.

STARTING FORCE.

The force required to start a car and to get up speed is necessarily greater than that required to maintain the speed uniformly. "It is a variable quantity," says Mr. D. K. Clark, in his admirable book on tramways, "for it may be anything that horses choose to exert." But it has been found by experiment that the momentary starting force is about four times the tractive force when once in motion; thus we may form a rough idea as to the exertion of a horse in starting a car on the level or on an incline. Horses cannot tell us of their sufferings; we know, nevertheless, that their life in the tramway service is but short, although they work no longer than three to four hours a day. It is barbarous to use horses, as these figures show, yet there has been until recently no economical substitute, and it is only within the last few years that mechanical traction has made any headway. That mechanical power will supersede animal power, and that at no distant date, is admitted on all hands, but the question of the kind of mechanical power to be employed is still an open one. It is often asked why so much mechanical power is required for the propulsion of tramcars, and why it is that a tram locomotive should be made to give as much as 40 indicated horse-power and more, whilst two horses seem to do the same amount of work.

The above table shows what mechanical work is actually being done. James Watt ascertained experimentally that a strong dray horse is capable of producing a continuous effect of 33,000 foot-pounds per minute; but we see that one tram-horse does the work of three or four dray horses very frequently. When we consider that a tramway steam-locomotive often weighs from 8 to 10 tons without the car and passengers, it becomes evident that the indicated horse-power above given is no extravagant measure. Take a locomotive, car, and passengers as weighing together 13 or 14 tons, then, in order to move that load on a level road at a speed of 7 miles per hour, with a tractive force of 30 lbs. per ton, we require from 7 to 8 actual horse-power, which is equivalent, after allowing for engine friction, to about 11 indicated horse-power; and, when traveling up an incline of 1 in 37, something like 34 indicated horse-power. Reducing our figures to a co-efficient, and maintaining that the tractive force is 30 lbs. per ton on a level but dirty road, we come to the conclusion that, when moving at a rate of 7 miles per hour in a straight line, we shall consume 8 foot-pounds of work for every pound of weight on the rails; on an incline of 1.75 we consume 16 foot-pounds, and on an incline of 1.37, 24 foot-pounds for every pound weight carried at the same speed. Therefore it is of the utmost importance to reduce the dead weight to be propelled to a minimum. Where the locomotive engine has to drag the car behind it, it becomes necessary to provide weight in order to obtain good adhesion on the rails, and the best plan, no doubt, would be to utilize the weight of the car and passengers for this purpose.

The number of steam locomotives employed on tramways is daily increasing, and steam traction is gaining in public favor. It is not, however, within the range of this paper to examine into the advantages or disadvantages of steam traction; but merely to show whether electric tramcars have any chance of success from a utilitarian point of view. We distinguish between the terms electric cars and electric tramway or railway; the electric car carries its energy within itself, and is quite independent of external influences; whereas, in electric tramways, the energy, electricity, is conveyed from the generating station to the rails or other conductor communicating with the motor which turns the car wheels. Separate conductors are used by Messrs. Siemens, at Portrush or elsewhere; Mr. Magnus Volk, at Brighton, conveys the current through the rails—the nature of the ground (shingle) on Brighton beach does not allow of any accumulation of rain or dirt, the rails are above ground, and there is no traffic across the line; an electric tramway is being constructed at Blackpool, where current is conveyed through conductors in a pipe laid underground between the rails; this pipe has a slot throughout the whole length to permit of the connection between the car motor and the conductor beneath the surface of the road. Our electric car, as the model shows, requires no conducting medium; it does not interfere with the rails or roadway nor with other traffic, and it can be shifted from one line to another of the same gauge, it can be run in conjunction with the ordinary horse-cars.

THE BATTERY.

In order to make an electric car, we require a battery which can be stowed away within the car. Such battery has to be of small weight, must be reliable, supply any quantity of current according to the exigencies of the road, must be cheaper than horse flesh, and emit no smell. Primary batteries are out of the question; the cost of zinc consumed in them would be much greater than that of animal power, independent of the difficulties attending the process of refilling such batteries when exhausted. The invention of the secondary (storage) battery put the question entirely in a new light; certain successful laboratory experiments at once suggested the adaptability of this invention to the propulsion of vehicles. Four years have elapsed since the introduction of the Faure accumulator into this country. It caused quite a sensation at that time, and money could be found in abundance for the exploitation of anything that bore an electrical name. Things have changed entirely since then. The original Faure battery has never been of any practical use, and very substantial improvements had to be made, at enormous expense, to bring the secondary battery to a commercial value. The Electrical Power Storage Company have acquired the patent rights of M. Faure; in addition to those of Messrs. Sellon, Swan and

[1] Paper read before the Inventors' Institute [England]. From *Iron*.

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Volckmar, and they have, step by step, improved the mechanical details of these storage batteries, until they arrived, after immense labor, at what may be termed a thoroughly practical article. But the prejudices created in the public mind by early failures have not quite worn off yet, and it will require something wonderful and startling to convince the public that the work of the last four years has produced remarkable and practical improvements.

None but those who have been intimately connected with the manufacture of storage batteries can form an adequate idea as to the numerous difficulties which had to be surmounted before a permanent success was attained. The battery was long perfect from a theoretical point of view, but it could not stand the test of time—time was an essential factor; it took many months to test the durability of a set of cells, and it was only by close observation and careful remedying of defects, one by one as they appeared, that the storage battery assumed its present form—simple as they may appear to the uninitiated. The cell before you is one of a set of the type specially designed for tramcar work. In a lead-lined strong teak box are placed twenty-one lead plates, weighing together 26 lbs. inclusive of connecting strips and terminals. Ten of these are called positive, and eleven negative. Each plate is formed of a leaden grid, the perforations of which are filled with a paste of lead oxide; the positive plates contain red lead, which, in charging, is converted into peroxide; the negative grids are filled with a paste of litharge, which, in charging, is reduced to spongy lead capable of absorbing hydrogen. We store, therefore, not electricity, but oxygen and hydrogen, which gases, when the battery is discharging, manifest themselves externally in the form of electrical energy. The box is filled with sulphuric acid and water of a specific gravity of about 1150°; then a lid is put on, sealed all round the edges to prevent any spilling of the acid. This acid is never removed so long as the battery lasts. There is no reduction of lead or any material going on within the cell, and the battery would last forever, but for the fact that the lead grid of the positive plates becomes so brittle through oxidations that it crumbles to pieces in course of time; then, these positive plates have to be replaced periodically by new ones; but the old lead is valuable. The life of a positive plate depends entirely upon the amount of work it has done. The plates in the box before you have been at work since September last, and are still in excellent condition—we should say they are still as good as new. They have frequently been discharged at the rate of 100 ampères, whilst the average working current is 46 ampères, they are always charged at the rate of 32 ampères, and their storage capacity is 150 ampère-hours. Sixty such cells will weigh 1¼ ton, and propel a car with forty-six passengers for about two hours over a road with ordinary gradients, curves, and sixty stoppages per hour.

The diagram (which was exhibited by the lecturer) represents such a car, which has been running at Millwall and at Battersea. The accumulators are placed on trays under the seats out of sight. These trays can be drawn out through doors at one end of the car, and replaced in a few minutes. A trolly containing a fresh set of trays and rollers is drawn up to the end of the car. The discharged cells are pulled out all together by means of a small winch, and the newly-charged cells pushed in, when the car is at once ready to proceed on its journey. There are three sets of accumulators to each cars, two sets being charged, while one set is propelling the vehicle, thereby saving time and preventing delay.

THE ELECTRO-MOTOR.

This machine has to convert the electric current into mechanical power. For tramcar propulsion it is absolutely necessary that the motor should have a high efficiency, and, at the same time, be of small dimensions and of light weight. To combine these requirements has been the aim of the author, and he has, at length, produced a machine which has had some rough tests in actual service under the most trying circumstances and conditions. There are two motors driving the car, each capable of working up to nearly 9 h. p. and weighing 420 lbs. Each motor is supported independently upon a small bogie; the whole mechanism is self-contained; and each separate bogie forms a small locomotive engine, upon which the car rests. One axle of each bogie is a driving-axle. Thus we obtain four small driving-wheels, which give the requisite grip upon the rails. Either bogie can be detached from the car in less than one hour, so that in case of repair and inspection the motor can be taken out and replaced without letting the car stand idle for any length of time. The speed of the motors is high, about 1,000 revolutions, when the car is running at 7 miles an hour; thus it is necessary to introduce some mechanical reducing gear between the motor-shaft and the driving-axle.

THE GEARING.

The gearing so employed consists of a worm on each motor-shaft and worm-wheels on the driving-axle giving a ratio of about 1.12. This worm-gearing is boxed in, as likewise is the motor, and the wheels run in oil, dirt is thereby excluded, and the lubrication kept perfect. Easy access is obtained to motors and lubricators through doors in the floor of the car.

VARIATION OF SPEED AND POWER.

This is obtained by means of a compound switch, which arranges the motor-circuits so that the machines shall work in series, in parallel or singly; thus the resistance of the circuit being varied, the power and the speed vary accordingly. When a greater range of speed is desirable, the motor-circuits are still further divided by arranging the field magnet wires apart from the armatures. This obviates cumbersome gearing, which would add to the weight and the expense also—increase first cost and maintenance as well. The driver has full command over the motive power; one handle sufficing for all the operations of starting, stopping, and varying the speed or power. There is no useless electrical resistance, and, therefore, no waste of energy, whatever speed the car may be traveling at. The car is provided with these details at both ends, so that the driver has only to remove the handles and two connections when arriving at the journey's end, and then proceeds. It would be an easy matter to vary the speed by decreasing or increasing the number of cells, thereby varying the electromotive force; this method, however, is injurious to the accumulators, because some of the cells would be discharged sooner than the others, and when they are all recharged in series, some would have to be very much overcharged before the rest could receive their proper share. There would be not only a waste of power occasionally by the evolution of gases for no purpose, but the life of the cells and their efficiency is reduced by this irregular treatment.

THE BRAKE POWER.

At each platform there is the usual vertical shaft and brake-handle. A chain is wound upon this shaft when the handle is turned, and eight brake blocks are simultaneously pressed against the corresponding number of wheels. The car can be stopped almost instantaneouely; but beside this there is an electrical brake, so that the motors act as dynamos driven by the momentum of the car or by the car running down an incline; the whole power stored up in the momentum of the car is converted into electricity and the current generated is utilized in magnetizing the brake-blocks, thereby increasing their grip upon the wheel tires. Arrangements are being made to render this electric brake automatic, so that the main circuit will be broken and the brake-circuit with the motors closed automatically when the speed of the car attains a certain maximum.

COST OF MOTIVE POWER.

It has been mentioned that the capacity of the tramcar cells is 150 ampère-hours. We do not exhaust them en-

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tirely, but leave a margin of at least 20 per cent. in the cells. A charge of 120 ampère-hours is sufficient to propel the car full of passengers for two hours, or about 12 miles over an average road with frequent stoppages. When charging 60 cells at the rate of 32 ampères for four hours, and replacing the accumulators in the car every two hours, we require steam power to the amount of about 1 indicated h. p. per car. Assuming that the car has to run 72 miles a day, and that we are supplying several cars at the same time from one engine, the fuel consumed need not exceed 4 lbs. per indicated h. p. per hour. The charging takes place during 12 hours of the day only. Thus 7 cwt. of coal per car per day will give a consumption of about 10 lbs. of coal per mile. Reckoning the price of coal at 18s. per ton, the fuel per car-mile would cost less than one penny ! By working longer hours, we could do with smaller engines, but, of course, with the same consumption of coal per car-mile. The most economical steam tramway locomotives burn from 9 to 11 lbs. of coal per mile, or about the same as quoted for the electric car. There are two reasons for this consumption. Firstly, the steam locomotive weighs four times as much as the accumulators and electric motor and driving gear—therefore, it requires greater power for its own propulsion ; secondly, a tramway locomotive boiler and engine cannot be expected to compete with a large stationary engine as regards economy. The loss thus arising from the conversion of steam power into electricity, and the reconversion of electricity into mechanical power is more than compensated by corresponding advantages. There are instances where water power is available within a reasonable distance from the tramway depot, in which cases the additional economy will be manifested.

PRIME COST, MAINTENANCE AND DEPRECIATION.

The steam engines, boilers, dynamos, and shafting, and all needful apparatus for a charging station to supply a dozen electric cars, including spare power, will cost £4,000, and the complete equipment of 12 two-horse cars, inclusive of ample spare gearing, may be estimated at £6,000. The superintendence of machinery at the charging station will cost £1,100 per annum ; fuel at 18s, per ton, water, oil, and waste, £1,400 ; depreciation, at 10 per cent., on engines, boilers, and dynamos, £400 ; and an estimated depreciation of 35 per cent. on the whole propelling apparatus. This gives a total expenditure of £5,000 per annum, which is equivalent to 3.5d. per car per mile run. You will observe that these figures are thoroughly reasonable and allow of a good margin. We should have almost to annihilate the whole concern at the end of a year in order to bring the working costs to such an amount as is now allowed by some tramway companies for horsing !

SUMMARY.

I have pointed out the chief but yet only a few of the advantages of this system over horse traction, and I will in a few words enumerate them :

1. Economy in cost of running, which is estimated at about 3½d. per mile, including depreciation.
2. The appearance is that of the cars now in general use, and these latter can be readily converted.
3. The wearing parts of the mechanism which drives the wheels are few in number.
4. The total weight of the motive power mechanism is less than two tons distributed over two small bogies, whereby the load per unit of rail section is rendered even less than in the case of horse cars.
5. The propelling apparatus is invisible to the passengers, noiseless, clean, and perfectly safe.
6. One man (not necessarily skilled) is sufficient to drive an electric car.
7. The car may be illuminated at night by the electric current sufficiently to enable the passengers to read with comfort, while effecting a saving over oil lamps in cost and avoiding their dirtiness. The power required is so small that the cost may be neglected; the 20-c. p. lamps used consuming only three ampère-hours out of the total of about 150 ampère-hours given by the cells.
8. The maintenance of the permanent way (including paving) is less than with horse cars, where the hoofs are continuously striking in the same tracks. Existing rails will serve for the electric car of this system, and no additional rail or tube or breaking up of the road is necessary, preliminary to its adoption.
9. The space required for a charging station is much less than that necessary for stables for a corresponding number of horses.
10. The same plant which charges the storage batteries may be utilized for lighting the depot and other neighboring buildings by running extra hours at trifling further cost, thus yielding additional revenue.

DISCUSSION.

Professor George Forbes, F. R. S. E., gave a short and concise account of the electric railways laid down in various parts of the world within the last few years, and he considered the methods of conveying the electricity through rails or other conductors clumsy and unsatisfactory. In Mr. Reckenzaun's tramcars they had no stationary engine connected with it by a conductor, and this he considered, other things being equal, a very great advantage. After the experiments made by M. Philippart with tramcars propelled by a Faure battery, he was glad to hear Mr. Reckenzaun say that storage batteries had at last been made commercially useful and practical. He now believed the difficulties which had encountered secondary-battery makers in the past had been surmounted, and that the method of constructing them had been so enormously improved, that those who used them were now masters of the situation instead of *vice versa*. Pointing to the battery exhibited on the table, the speaker said every one was struck with its light weight, which was brought about by its being made of thin plates, thus giving a large surface and a greater current than had ever been found before in a secondary battery. This he considered one of the chief things they had to be thankful for, because this bringing within a small compass sufficient power to last for a few hours had been their stumbling block in the past. He had been informed that it was impossible to overcharge their batteries and that this could be done for months and months, but it is mentioned in this paper that this overcharging is detrimental to their working. The method of varying the speed and power devised by Mr. Reckenzaun is extremely ingenious and simple, avoiding the disadvantages of mechanical arrangements which would necessarily arise with numerous wheels, chains, or the like. As to the efficiency of electrically-propelled cars as compared with other means of locomotion, he thought that, although steam had made great progress of late years in the propulsion of tramcars, it still had very serious drawbacks, among which were that a small portable locomotive was far less economical than a stationary engine, especially as for the former they had to use a superior quality of fuel. Comparing the Scott-Moncrieff compressed-air car with the one then under discussion, professor Forbes remarked that it seemed to him that the arguments which applied to one applied to the other, and also pointed out that in Mr. Reckenzaun's car they saw for the first time the application of a worm-wheel to reduce the speed of the motor. In conclusion, he said it was satisfactory to hear that Mr. Reckenzaun was using electricity itself as a brake upon his car, because he thought that where electricity was applied as a motive power it ought also to be used as a brake power.

Mr. Traill (Giant's Causeway electric tramway) said that electric tramway engineers had a great battle to fight. They did not want to replace steam, but to aid railways and, at the same time, the outside public. He thought that through electricity underground railways would become things of the past. There was also the system of overhead tramways, such as was used in America, and which

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the electric motive power was essentially fitted for, as it did away with the noise and dirt. There were four systems of utilizing the electric energy, and there was no doubt that the system carrying its own motive power, self-contained in its own car, had very great advantages indeed over any other system. The different systems were those which had overhead conductors, those which had side conductors, those which had underground conductors, and the system of accumulators. The overhead conductor was suited to very few places; then there was the side conductor, which they had adopted on the Giant's Causeway tramways. This system was very economical, and had many advantages, but after all was only applicable in very few places. There was the underground conductor which could be adapted to street tramways. The fourth system, viz., that of accumulators, had many advantages; indeed, it could be used on any line now worked by horses or steam. After repeated failures at the Giant's Causeway, they had at last hit upon a thoroughly reliable plan for getting the electricity from the conductor. This was by means of a steel spring in the form of a carriage spring, two concave steel springs fastened at the top and rubbing along the bottom.

Professor Forbes: "How long do they last?"

Mr. Traill replied that they had some running for nearly a year, and, when new, they only cost 5s. 6d. He was very much pleased with the system of Mr. Reckenzaun, and, having no doubt that it would come into very large use, he wished it every success.

Mr. Bernard Drake was of opinion that electric cars would have to be made smaller than those which had up to now been constructed in accordance with Mr. Reckenzaun's designs. He pointed out that not only would the smaller cars be more tractable in case of accident, but also that the question of stopping the car would not be so serious, as it stood to reason that if there were forty-six passengers on a car instead of twenty-three, the driver would be compelled to stop double the number of times in a given distance, and that the question of starting such a big car as now used was a severe strain. He considered that the arrangement adopted by Mr. Reckenzaun, of coupling the motors in series or parallel, or running a single motor, was both ingenious and practical; but as regards the overcharging of the extra cells, he thought that the question was more one of carrying the dead weights of these extra cells, which Mr. Reckenzaun had so ably explained was of the greatest importance in ascending gradients, than the mere destruction of the cells themselves. It was, of course, wasteful to expend your power in the evolution of gas after the cells were full, and would tend somewhat to soften the peroxide which might, therefore, be more liable to drop out when jolted by the car. He maintained, however, that the overcharging was not nearly as detrimental as was generally supposed. Mr. Drake drew attention to the large output per pound of lead obtained from the tramcar pattern of cell, and the general practical nature of the supporting of the plates and connections, and stated that, as manager engineer of the Storage company, he felt certain that the company was greatly indebted to Mr. Reckenzaun for the developing of the cells in connection with this class of work, inasmuch as numerous questions of detail had been found out by him, and that by these experiments a most valuable advance had been made in this class of accumulator. Referring to air cars, he thought there were very decided advantages in favor of the electric car, not only in weight, but also from the fact that the pressure of air began to fall from the moment the car came into use, for which mechanical arrangements had to be provided, and also the freezing caused by the expansion of air had to be faced, whereas in the electric car the E. M. F. is practically constant throughout the run, also the electric car would hold its charge for weeks together, whereas the air car charge would entirely leak away in a night.

Mr. Traill rose again and stated that his cars in Ireland have successfully traveled over 30,000 miles with 100,000 passengers, and that the electricity generated by water-power a mile distant costs one-quarter that of steam used on the same tramway. The commutator of the dynamo made 22,000,000 revolutions before it required repairing.

Mr. Shoolbred, M. I. C. E., said that he had seen Mr. Reckenzaun's car running on a difficult piece of line at Battersea, and he was struck with the simplicity of the system and the completeness of design in every detail. He thought that Mr. Reckenzaun's plan of varying the power and speed was just as applicable to a tramway having the current supplied through conductors as it is with accumulators.

Admiral Selwyn, in the course of some general remarks, said he hoped the Inventions exhibition would help the inventor to take his proper place in the country instead of being absorbed by the manufacturers, which was, after all, only one result of a defective patent law.

Mr. Waugh having spoken in encouraging terms of the prospects of electrical engineering, the chairman called upon Mr. Reckenzaun to reply.

Mr. Reckenzaun, in reply, testified to the great pleasure and instruction he had derived from the observations of professor Forbes, Mr. Traill, and the other speakers, and that he felt highly encouraged by the remarks of such authorities. He pointed out that the comparisons made by professor Forbes between compressed-air cars and electric cars do not hold good in all points, although there is a great similarity in principle. Compressed-air cars are much heavier, the weight of the air reservoirs under the car and its engine cannot be less than four or five tons if made to run eight or nine miles with a pressure of 500 lbs. to the square inch; the accumulators, motors, and gearing in the electric car weigh under two tons in order to propel the vehicle with forty-six passengers over a distance of 12 to 14 miles, and the time occupied in changing the cells at the end of the journey need not occupy more than three minutes. The moving parts in the mechanism of the air car, like those of the steam car, are at least five times in number as compared with the parts on the electric car, and this must be taken as a very great advantage. Moreover, the efficiency of the compressed air engine is lower than that of the accumulator and electric motor. Mr. Drake has very justly said that whilst the pressure in the air-car is gradually falling, the current of the electric battery is constant throughout, but as regards Mr. Drake's opinion that small cars may be more efficient than large ones, Mr. Reckenzaun remarked that a car capable of carrying only twenty-three passengers will weigh much more than half the weight of a 46-passenger car, and that if the traffic is sufficiently large, the bigger cars may be more economical. As regards the overcharging of the batteries, if some cells were used more than others of the same series, which would occur were the speed and power regulated by the number of cells, more stress should have been put in the text of the paper upon the fact that the energy wasted is more serious than the fact of sooner oxidizing the lead plates. Still, the object of the present system of regulation removes both these drawbacks.

THE PROPER METHOD OF OBTAINING THE AVERAGE DURATION OF AN INCANDESCENT LAMP.[1]

BY J. A. FLEMING, M. A., D. SC.

Recent statements on the average life of incandescent lamps and other general practice agree in indicating a certain absence of clearness in many minds on the proper principles by which the desired average quantity can be obtained from the experience of observations. It seems desirable, therefore, to call attention to the proper method by which alone any figures at all useful can be obtained. To do this we shall adopt, what is always best when possi-

1. The *Electrician* (London).

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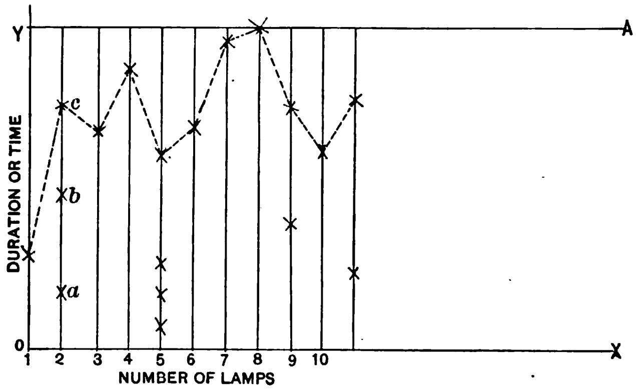
ble, graphic illustrations instead of symbols. Let us suppose that there is an incandescent lighting plant set up for continuous or intermittent use, and that the person in charge desires to arrive at some correct notion as to what is the mean duration of the carbon filament under any condition of working. On a line, o x, mark off equidistant



points, each one of which represents a working lamp. Draw vertical lines through these to represent time or duration, and the crosses represent the time or dates at which lamps are replaced. Thus in the diagram, lamp 2 is replaced at three periods, represented by the crosses *a*, *b*, *c*; the first lamp burnt for a time 2*a*, the second for a time *a b*, the third for a time *b c*, and the fourth lamp is yet burning.

Now, suppose that a trial period of time is taken, represented by the distance between the horizontal lines through A and X. The distance A X represents the duration of this trial run. Supposed it is desired to obtain the average life of the lamps during this period, then the *usual* mode of arriving at this quantity would be to divide the total lamp hours by the number of replaceals, and deduce (perhaps to a decimal) the average life of the lamp. If matters could be so managed that if the lamps all gave out at once, and that the trial run finished exactly with the expiry of all lamps, it is obvious that the above mode of procedure would be correct; also if the lamp hours of every separate lamp were taken from the beginning of the trial up to the end of the duration of a life, the same having been replaced 1, 2, 3 or *n* times. Then it is also obvious that the average life would be the average of the average deduced by dividing the whole lamp hours of *each* lamp separately by the number of times that lamp has been replaced. But neither of these two processes is practicable in a general way, and accordingly we can deduce no accurate average from any trial in which there remain at the end of the trial unexhausted lives, or lamps which have in them yet lamp hours of potential working. Referring once more to the diagram above, we see that the diagram may be divided into two parts, one above the dotted line formed by joining all the last crosses and one below. The united lengths of all the vertical lives included between the dotted line and the horizontal O X represent the lamp hours of burnt out lamps. The united lengths of all the parts of vertical lines between the dotted line and the upper horizontal, A Y, represent the lamp hours burnt by lamps yet alive and likely to live.

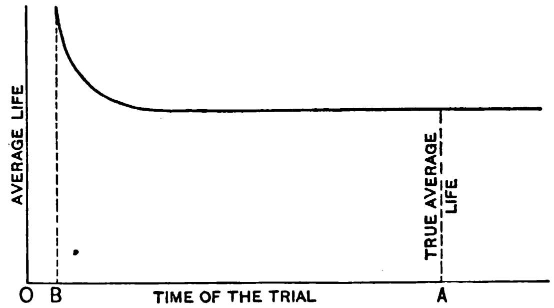
Now let us call these two parts the total exhausted lives, and the total unexhausted lives.

If the lamp hours of unexhausted lives form an appreciable or moderate fraction of (much more if it exceeds) the lamp hours of exhausted lives, then the application of the common rule only leads to ridiculous results. And the only circumstances under which the quotient of total lamp hours by replaceals gives a correct approximation to the average life is when the total unexhausted lamp hours is small or negligible in comparison with the total exhausted lamp hours. And under the former supposition the average life is always overestimated. Accordingly, the moral of this is, no trial tests or experimental runs are of the least use for the purpose of averaging the life of incandescent lamps which do not last for a period at least four or five times the average duration of a lamp, that is for 5,000 or 6,000 hours, and the longer the better.

If a given number of lamps be set up and run continuously, and replaced as they fail, and the ordinary rule applied at stated intervals, it would be found that as the trial run extends in time, the average life deduced would diminish towards a fixed minimum, which is the real average.

It is easily seen that the ordinary rule makes the average life of a lamp infinite for short trials, which, as Euclid would have observed, "is absurd."

If we plot down the results of applying the common rule as ordinates along a scale of time representing the time of the trial, then it is easily seen that for time zero, life is infinite; and as the time of the trial increases, we eliminate more and more the respective proportion of unexhausted lives as compared with total lamp hours of exhausted lives, and approximate to a horizontal position in the life curve, which gives the true average life by its distance above the horizontal line. These considerations if weighed will, it is so to be hoped, prevent those in charge of installations from rushing into print with statistics derived from one or two hundred hours of burning. Although, as the results of



such too limited experience will always be to bring out the average life of the lamp too high, it is, perhaps, hardly likely that lamp manufacturers will refrain from quoting them in their own favor, or come forward to instruct the publisher of them in the true principles which should control the collection of observations intended to furnish an approximate estimate of the mean duration of incandescent lamps properly used.

One further remark suggests itself in connection with the statistics which have given rise to discussion on this subject, and it is this, the vital importance of working all lamps at the proper E. M. F. necessary to make the expenditure of energy in them equal to the proper watt mark of the lamp. And knowing as we do what serious variation is made in the average life by a difference of one or two volts (considered by many of small importance), it is obvious that the careful and systematic use of known accurate voltmeters should be a matter of consideration with every one who has the care of incandescent lighting.

RIVER CROSSINGS IN COCHIN CHINA.

The longest spans of overhead telegraph wire in the world have recently been put up by the French authorities in Cochin China. These are erected across the river Mekong, posts 160 feet high having been placed on each side of the river at a spot where the width is 2,560 feet; and from these silicious bronze wires—one .04 of an inch and the other .055 of an inch in diameter—are suspended across the stream. Over a tributary of the river another similar connection has been made 1,670 feet span and more than 114 feet above flood water.

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DYNAMOMETERS.[1]

BY C. F. WHITE,

Member of the Engineers' Club of St. Louis.

POWER measurement has been carried on ever since prime movers have been employed, and the great variety of devices for such measurement are but different forms of dynamometers..

The friction-brake and the indicator represent two classes of power measuring machines in very general use. But the word dynamometer is acquiring a narrower and more technical meaning, so that at present it most often means a machine for transmitting and, at the same time, measuring power. Hence the full name, transmitting dynamometer.

The demand for this class of instruments has increased with the movement toward centralization in development

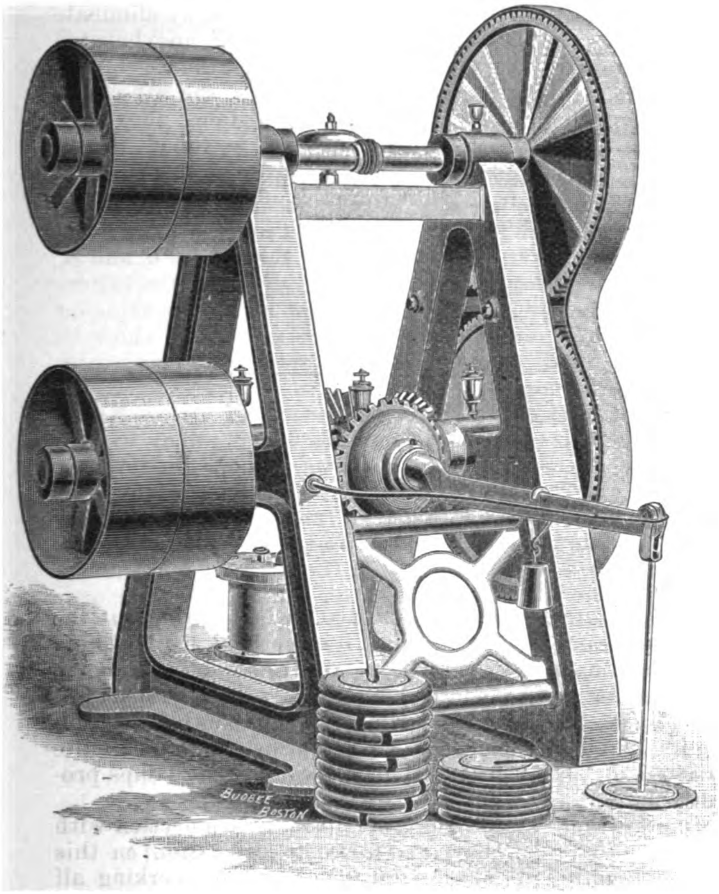

FIGURE 1.

of power, and also with the growing call for a more exact knowledge of the power required for various kinds of work. Members of our club have informed us of the excellent appliances at hand for the measurement of gas and of water, and I am glad to call your attention to several recent forms of power-meters, fully equal, I believe, in convenience and accuracy to gas or water meters.

Right here I ought to say that most of the dynamometers which I shall mention have been described at different times in technical and engineering journals. A short review of their leading features will not, I believe, be amiss.

In a transmitting dynamometer some element of a train of mechanism is deviated from its normal position by the force transmitted. This deviation is resisted and measured by weights or by springs.

If three gear-wheels be run together, there is an effort exerted on the axis of the intermediate one, tending to move it out of position.

When power is transmitted by a pulley, the arms bend more or less from their original shape.

One part of a belt is tightened, and another part relaxed, by the transmission of power through it.

In that form of transmitting dynamometer devised by Wm. Kent, M. E., the shaft carrying the intermediate gears is arranged as a pendulum, and in its normal position hangs vertically. The force transmitted through the box-mitre-gears swings this pendulum from the vertical. This swing movement causes a pencil to traverse a paper drum having a motion at right angles with the pendulum plane, and proportional to the speed of the gear-wheels. A suitable clock-work marks equal intervals of time on the paper. From the diagram thus produced, the intensity of the force and the distance through which it has acted may be read and the power determined.

The "improved balance dynamometer,"[2] figure 1, also uses as the deviating element box-mitre-gears. A double-letter "A" frame carries across its top a shaft on which, at one end, is a large spur-wheel, at the other tight and loose pulleys. Across the centre-bars of the frame extend the two gear-shafts, one of which has a spur-gear, and the other tight and loose pulleys exactly like the upper shaft. The arm carrying the intermediate mitre-gears is prolonged into a scale-beam. The tendency of this beam to rotate, when transmitting power, is overcome by weights hung to it. A small gong is struck at the end of each hundred revolutions of the shafts. The scale weights are so stamped that by dividing the number on them by the number of seconds to each hundred revolutions times the equivalent of a h. p. in foot-pounds per second, the h. p. transmitted is obtained:

$$\frac{\text{Stamp.}}{\text{Seconds to 100 rev.} \times 550} = \text{H. P.}$$

Mechanism for giving a continuous record may be used, if desirable.

The apparatus brought out by Hamilton Ruddick,[3] figures 2 and 3, consists of a sleeve secured to the shafting carrying on opposite sides radial arms. Loose upon this sleeve is a pulley having a pair of arms similar to those just mentioned. Between the ends of these arms springs are placed, which are compressed proportionally to the force transmitted from shaft to pulley, or vice versa. A pencil arm, pivoted on the sleeve and connected with the pulley by a link, moves, with the compression of the springs, across the face of a flat paper disc; and by its distance from the zero line indicates the intensity of the force transmitted. Motion of rotation is given to the disc by means of a differential gearing, actuated by a ratchet and a stud, which, projecting through the rim of the pulley, is moved once at each revo-

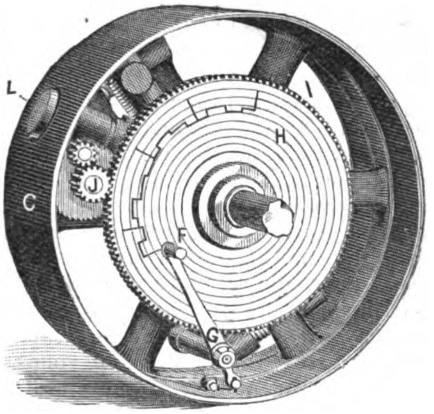

FIGURE 2.

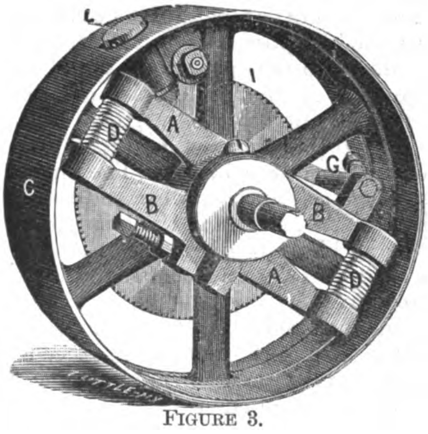

FIGURE 3.

1. Read before the Engineers' Club of St. Louis, April 29, 1885, and published in the *Journal of the Association of Engineering Societies*.

2. Made by Lawrence Machine Shop, Lawrence, Mass.

3. Made by Transmitting Dynamometer Co., 47 Astor House, New York.

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lution by the belt pressure. By a suitable adjustment of the gears, the disc may be made to revolve in any desired period of time, and from the distance through which the disc has moved a record of the number of revolutions is had.

Another transmitting dynamometer,[4] designed by F. Van Winkle, figure 4, has been recently put upon the market. A strong cast-iron plate is strapped to the arms of the transmitting pulley, the pulley being loosened upon the shaft. A second plate with a long hub is placed near the first, centred about and secured to the shaft by set screws. A pair of tension springs transmit the motion of one plate to the other, and are elongated in proportion to the load. The movement of the plates past each other becomes the

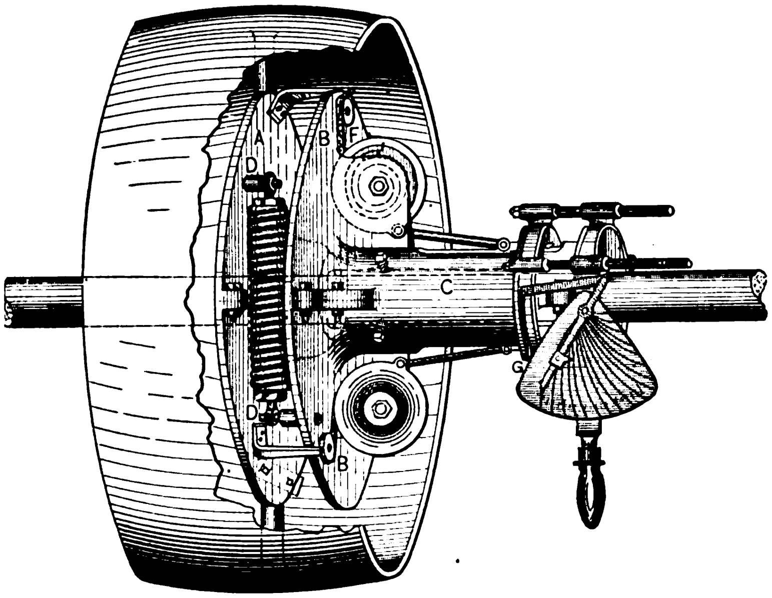

FIGURE 4.

measure of the transmitted force, and by means of a steel ribbon and suitable pulleys causes the hand on a stationary dial plate hanging from the long hub to move. The machine is so adjusted that, the diameter of the pulley and the number of revolutions being known, the h. p. is read off at once. Continuous record attachments are also made for the instrument.

The "Emerson power scale"[5] is a rotary transmitting dynamometer, by which the load is weighed with weights and levers, as in a common scale. A circular frame, or "spider," with a long hub, is secured to the shaft close up to the driving pulley. Around this spider is a rim free to rotate, and from which studs project and serve to connect it to the pulley. In transmitting power from the shaft to the (loosened) pulley, the tendency of the rim to rotate on the spider is resisted by a system of levers which communicate with a pendulum balance weight.

As the system of levers receives the transmitted force at a known distance from the centre of rotation, the distance traversed per revolution is known. A speed counter shows the revolutions, so that the force indicated by the pendulum times the number of revolutions per minute times the constant, divided by 33,000, is the h. p.

$$\frac{\text{Reading of scale} \times \text{rev. per minute} \times \text{constant}}{33{,}000.} = \text{the H. P.}$$

In reviewing briefly the machines described, the Kent and the Lawrence dynamometers form a class by themselves, as both are independent apparatus requiring setting up and special belting. Each machine is capable of being adjusted to do all that the other will do.

Of the three rotary dynamometers, the Ruddick stands somewhat alone, from the facts that it must replace the usual driving pulley and readings can be taken only when at rest. It is, however, very compact, and furnishes a convenient record sheet from which both force and distance can easily be read.

The Van Winkle and Emerson machines have in common certain features which recommend them highly for some classes of work. Both are so made (split) that they can be put on a shaft alongside the regular pulley without disturbing pulley or belt, save loosening the set screws. The dial plates hang quietly from the shaft, and the power may be read off at any moment.

In all of the dynamometers which we have just noticed, the record is made in a direct ratio to the force transmitted, and upon a scale not readily changed.

By the kindness of a friend, I am able to present to you to-night the details of a new transmitting dynamometer which have not before been brought before the engineering public. The apparatus has a number of interesting features, and I ask your attention to its construction, the theory on which it is based, and to its performance under severest tests.

This new dynamometer, which is sold under the name of Wales's portable dynamometer,[6] makes use of the difference in tension in the two parts of a belt transmitting power, figure 5. Two rolling pulleys, AA, swing upon pivots, CC, which are supported in castings, DD. The castings slide upon the bar E, so that by means of the chain F and the winding drum G the pulleys AA may be drawn together, causing the belt to contain the angles θ and β. These angles, being made equal in adjusting the instruments, the tension of the belt when at rest is the same on either side, and causes equal pressure on each of the rolling pulleys, tending to force them apart, but being prevented from doing so by the tie-rod O.

When motion occurs in the direction of arrow No. 1, any transmission of power from the lower pulley to the upper one causes an increase in tension along the "upper side" of the belt, and a decrease of tension along the "lower side." The difference of tension thus caused between the two parts of the belt forces the rolling pulleys and the tie-rod O to swing about the points C C in the direction of arrow No. 2. The latter action causes the arm H to move out of parallelism with the arm I, to which is fixed the bracket N. This movement extends the spring L until its resistance counteracts the pressure on AA, due to difference of belt tension. The movement of the arm H causes the pencil X to move outward upon the paper drum J. The latter is given a motion of rotation by means of a train of differential gearing, M, driven from the arbor of one rolling pulley. The combined motions of the pencil and the paper result in the tracing of a line, the height of which represents the force transmitted by the belt, and the length of which represents the length of belt passing over the rolling pulley during the time of the experiment. An inch of height of this pencil line will represent different amounts of belt tension, according to the value of the angles θ and β, and also according to the distance from C of the spring L, the spring being arranged to slide to four positions along the arms H and I. Consequently, by a proper selection of value for the belt angle and for the position of the spring, the pencil can be made to move through its maximum height for any amount of power measured. The following table exhibits the range of the instrument for various values of belt angle and position of the spring.

The table gives the h. p. represented by one inch height (or rise) of pencil line per 1,000 feet of belt travel per minute.

The figures in the first column are readings of an angle-gauge supplied with the instrument, and specially adapted to the measurement of the belt angle. The gauge is shown in the cut at *a d c* applied to the belt.

4. Made by Franklin Van Winkle, M. E., 22 Cortlandt street, New York.
5. Made by Emerson Power Scale Co., Lowell, Mass.
6. Made by Denton & Graydon Manufacturing Co., 55 Liberty street, New York.

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The graduations are made to represent the ratio of the tension along the belt, to the component of this tension acting along the line joining the centres of the rolling pulleys.

Directions for using are engraved upon it.

Measurement of belt speed is had in two ways:

1. By timing the revolutions of the primary gear-wheel. The primary wheel of the train giving motion to the paper drum is graduated to serve as a speed counter, each revolution of the wheel representing 100 revolutions of the rolling pulley. The circumference of the latter, for single belting, is exactly two feet. Hence each revolution of the primary gear-wheel represents 200 feet of belt-travel.

2. By measuring the length of the diagram. The differential gearing is so arranged that 1,250,000 revolutions of the rolling pulley cause one turn of the paper drum. The latter is $12\frac{1}{2}$ inches in circumference; consequently, each inch of length of a diagram measured parallel to the base-line represents 20,000 feet of belt travel.

The expiration of each minute is recorded on the diagram by a telegraph sounder carrying a pencil which bears on the paper, and which is caused to make a stroke once a minute by the passage through a mercury cup of the hand of a minute clock placed in battery circuit leading to the sounder.

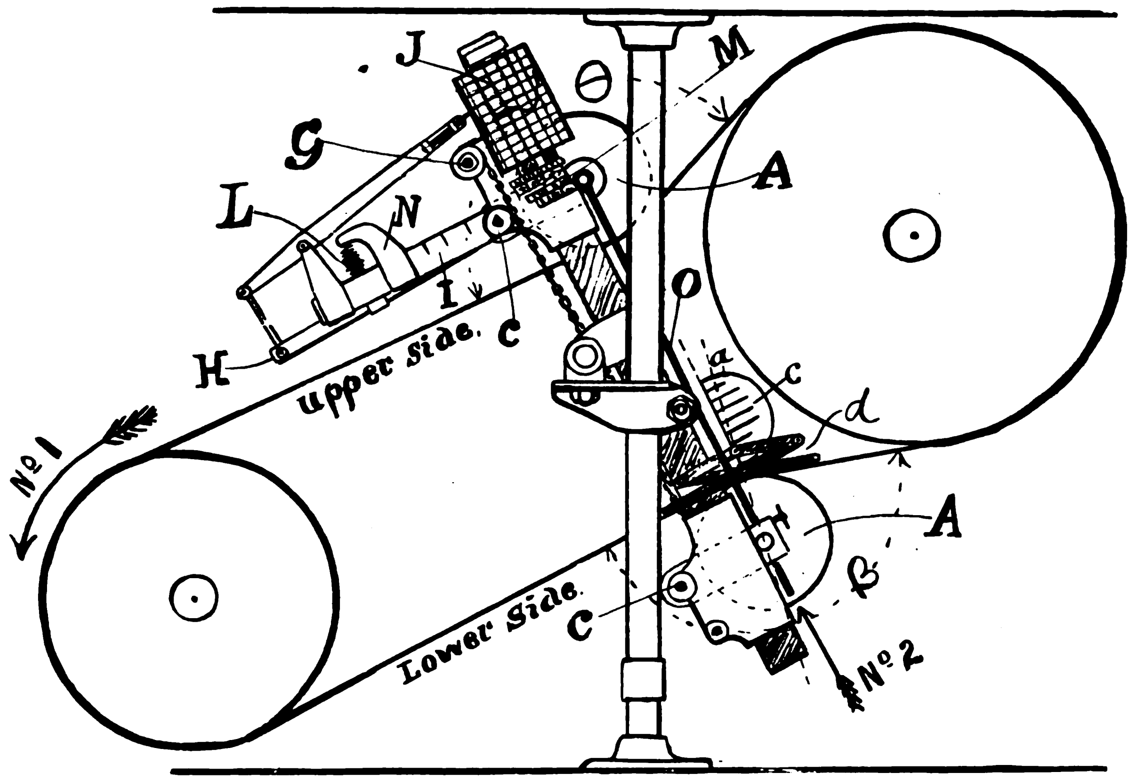

FIGURE 5.

TABLE.

Reading of Angle-Gauge.	Position of Spring.			
	Mark 1 H. P.	Mark 2 H. P.	Mark 3 H. P.	Mark 4 H. P.
1.	9.08	4.01	1.998	0.936
2.	4.54	2.02	0.896	0.468
2.5	3.63	1.61	0.717	0.374
3.	3.02	1.34	0.597	0.312
3.5	2.59	1.15	0.512	0.267
4.	2.27	1.01	0.448	0.234
4.5	2.02	0.896	0.398	0.208
5.	1.81	0.806	0.358	0.187
5.5	1.65	0.733	0.326	0.170
6.	1.51	0.672	0.299	0.156
6.5	1.40	0.620	0.275	0.144
7.	1.30	0.576	0.256	0.134
7.5	1.21	0 537	0.239	0.125
8.	1.13	0.504	0.224	0.117
8.5	1.07	0.474	0.211	0.110
9.	1.008	0.446	0.199	0.104
9.5	0.955	0.425	0.188	0.100
10.	0.908	0.404	0.179	0.094

An inspection of the table of h. p. shows the extraordinary range of the instrument. It will be seen that the scale of the diagram may be varied so that an inch of pencil motion may represent ninety-four one-thousandths of a h. p., or ten times this amount at 1,000 feet per minute belt speed. The maximum rise of the pencil is five inches. Hence, at the same belt speed, five inches of pencil motion could be produced by forty-seven hundredths of a h. p. with a belt angle of about 120 degrees, and the spring close to the rolling pulley; or five inches rise could control forty-five and four-tenths h. p. with a flat belt angle, and the spring at its farthest position on the arm H.

At electric light belt speed of 4,000 feet per minute, five inches of pencil motion would control 30 h. p. with the spring at position one and a moderate belt angle; while with the spring at four, about half a h. p. would move the pencil an inch. So that the full power of a 30-light dynamo on the one hand, or the power needed to merely overcome the friction of its journals on the other, could be recorded on a sufficiently magnified scale to insure accuracy.

This extraordinary range of capacity is due in a measure to the influence of the belt angles, but the principal cause is found in the fact that the movement of the spring affects the pencil scale as the *square of the distance* of the spring from the centre of the rolling pulleys. This will become apparent from a consideration of the appended statement of the theory of the instrument.

Let T = tension of the belt when at rest.

" ΔT = increase of tension on "upper side" = the decrease on the "lower side;" whence the resultant pressures upon the rolling pulleys are:

$2\ (T + \Delta\ T)\ \cos.\ \frac{\theta}{2}$ for "upper side" acting in the direction $f\ B$ bisecting θ.

$2\ (T - \Delta\ T)\ \cos.\ \frac{\beta}{2}$ for "lower side," acting in the direction $b\ R$, bisecting β.

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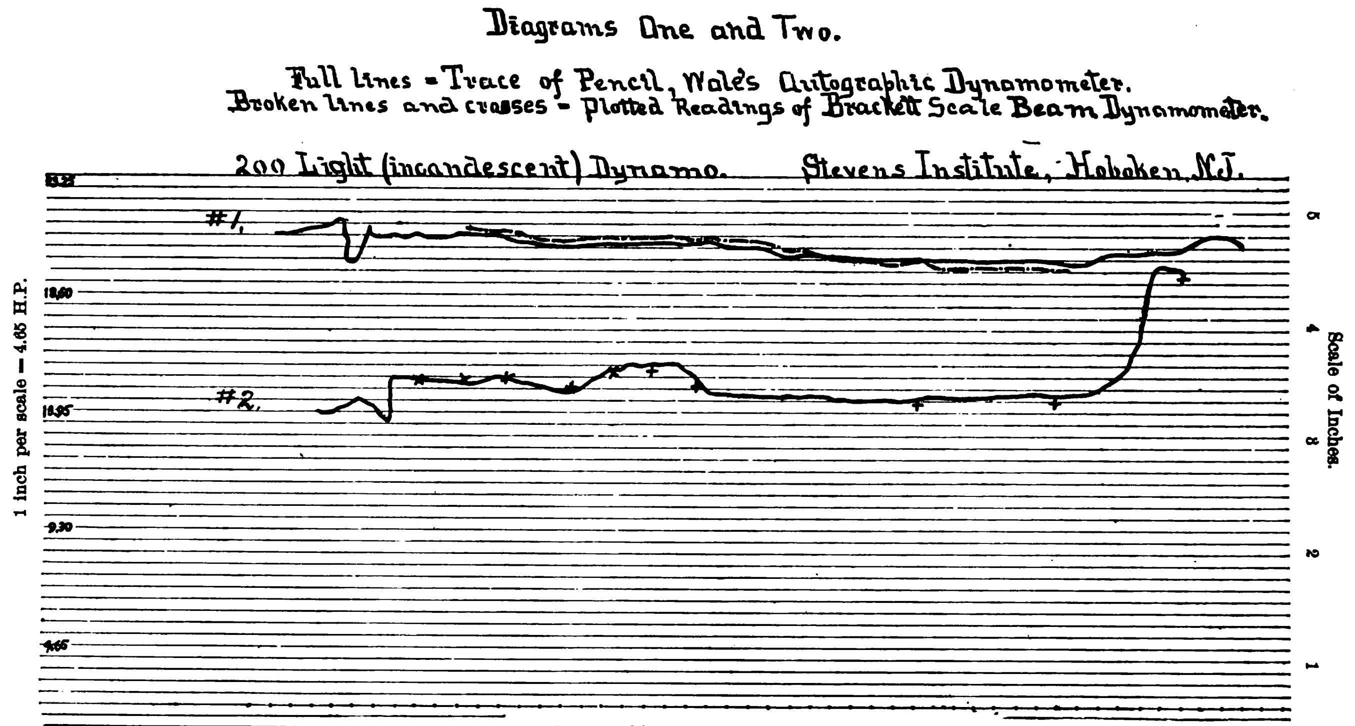
If α be the angle between the tie-rod (o) and the bisecting lines $f\,B$ and $b\,R$, then the above pressures resolved along the direction of the tie-rod are :

$\left[2\,(T + \Delta\,T)\cos.\frac{\theta}{2}\right]\cos.\,\alpha$ for "upper side" in direction $o\,B$.

$\left[2\,(T - \Delta\,T)\cos.\frac{\beta}{2}\right]\cos.\,\alpha$ for "lower side" in direction $o\,R$.

The difference between these two pressures is, putting $\theta = \beta$, $4\,\Delta\,T\cos.\frac{\beta}{2}\cos.\,\alpha$ acting in the direction of arrow No. 2, and it is this amount of force which causes the rolling pulleys and the tie-rod to swing about ($C\,C$) and extend the spring. The angle gauge is made and graduated so that if applied with the arms a along the belt and with the moment about C of this resistance will be $X\left(S.\frac{X}{L}.\frac{h}{\rho}\right)$ inch-pounds, which must equal the moment $l\;(2\;A\;\Delta\;T)$ inch-pounds. Or we have : $X\left(S.\frac{X}{L}.\frac{h}{\rho}\right) = l\,(2\,A\,\Delta\,T)$; whence the difference of tension represented by any height of the pencil, as h, is $2\,\Delta\,T = \frac{S\,X^2\,h}{A\,l\,L\,\rho}$ pounds.

The power transmitted will be, the belt travel times the difference of tension, or if $B =$ the belt travel in feet per minute, then the power in foot-pounds $= 2\;\Delta\;T\;B$. The h.p. $= \frac{2\,\Delta\,T\,B}{33{,}000} = \frac{B\,.\,S\,.\,X^2\,h}{A\,l\,L\,\rho.\,33{,}000}$, or per one inch rise of pencil, the h.p. $= \frac{B\,.\,S\,.\,X^2}{A\,l\,L\;33{,}000}$, or a constant times $\frac{B\;S\;X^2}{A}$



Autographic record of minutes made by Electric Register. Each dot marks the expiration of one minute = 3,850 ft. of belt speed.

the graduated plate so held that its straight edge is parallel to the tie-rod, the reading is equal to $2\cos.\frac{\beta}{2}\cos.\,\alpha$.

Let this be represented by A. Then we have that $2\;A\;\Delta\;T$ equals the force acting in the direction of arrow No. 2. But, $2\;\Delta\;T$ equals the difference of the tensions on the two sides of the belt ; hence the reading of the angle gauge is the ratio of the difference of belt tensions, to the component of this difference acting along the line joining the centres of the rolling pulleys.

We have, that the moment of $2\;A\;\Delta\;T$ about c must equal the moment of the resistance of the spring about c.

To obtain the latter, let—

$S =$ scale of the spring, or load in pounds required to extend it one inch.

$l = C\,R = C.\,\beta\,B =$ lever arm of the force $2\;A\;\Delta\;T$ about c.

$X = C\,N =$ lever arm of the spring about c.

$L = C\,H =$ lever arm of primary point H of the pencil motion.

$\rho =$ ratio of movement of H to movement of pencil point.

Then for h inches rise of the pencil the point H will move $\frac{h}{\rho}$ inches, and hence the spring will extend $\frac{X}{L}.\frac{h}{\rho}$ nches, whence the resistance will be $S.\frac{X}{L}.\frac{h}{\rho}$ pounds, and

And it is the value of this constant which is given in the table, B being expressed in thousands of feet. It is evident that the scale of the diagram varies as the *square* of the distance of the spring from C, and this fact is the principal cause of the great range of the instrument, which is such as to render the power transmitted per unit of weight of apparatus greater than any form of dynamometer yet devised.

TEST OF ACCURACY OF WALES'S DYNAMOMETER.

The following rigorous test of the instrument was made in the Department of Experimental Mechanics, Stevens Institute of Technology, Hoboken, N. J. :

The dynamometer was arranged upon a vertical belt, driving a large dynamo on the floor above. The dynamo was supported by an iron **U**-shaped cradle, hung upon knife-edges. Steel plates on wooden frames carried the latter. The axis of the dynamo-shaft and the bearings of the knife-edges we adjusted so as to be precisely in the same horizontal line. Thus the cradle and the contents were entirely free to oscillate about the axial line, and being delicately counterpoised, the centre of gravity of the entire mass was brought nearly into this axial line. Under these conditions a very slight force applied to the dynamo on a line *not* passing through the axis, as at the circumference of the driving pulley, would cause a sensible vibration of the

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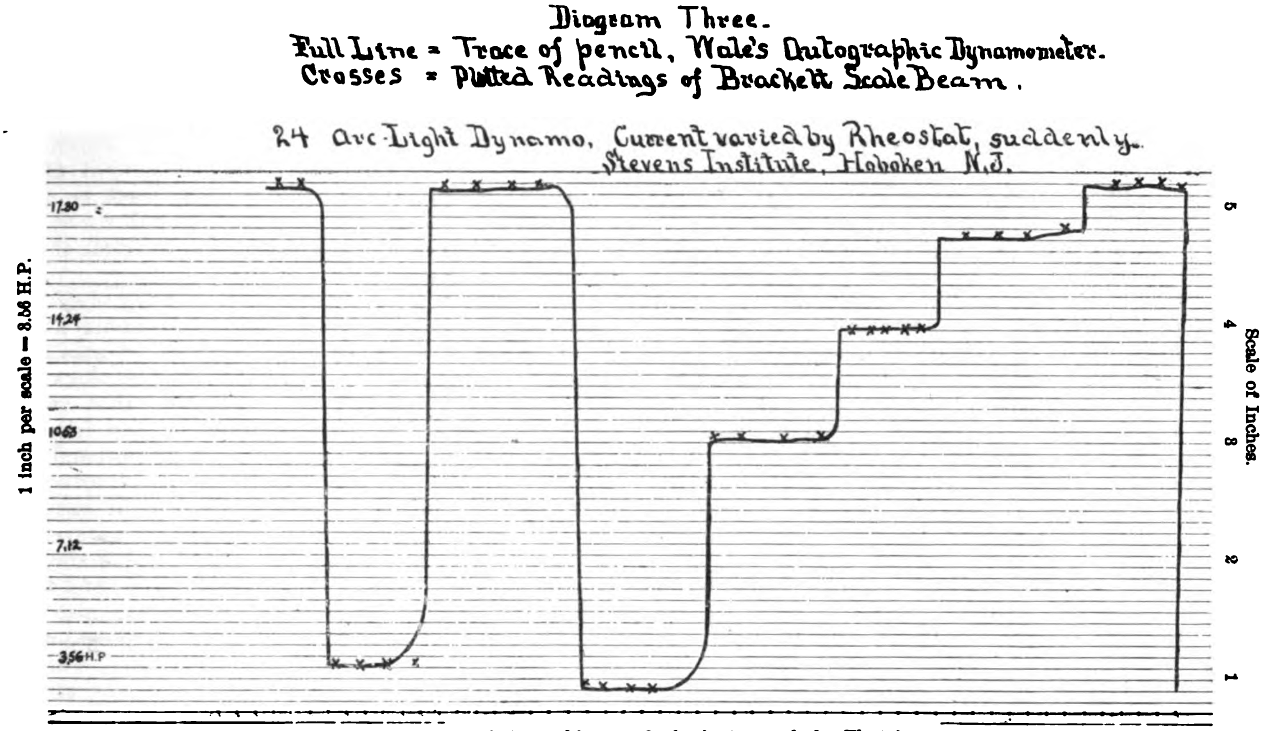
scale beam attached to the cradle, so that by applying weights to this beam the force exerted by the belt could be accurately weighed. The driving force being thus determined, the h.p. expended at the dynamo became known by observing the rotative speed of the spindle. This was measured by a speed counter attached to the spindle, and so manipulated that the revolutions were determined within one-third of one per cent.



Autographic record of minutes made by Electric Register. Each dot marks the expiration of one minute = 3,560 ft. of belt speed.

This method of weighing the power of a dynamo, which has been brought into prominence by Prof. Brackett, of Princeton College, is evidently as nearly perfect as practice can realize, for with properly designed knife-edges and careful balancing, the arrangement possesses all the accurate qualities of the steelyard, and must be regarded as the very basis of power measurement.

In the case of the apparatus at the Stevens Institute, a dynamo weighing 3,000 lbs. was so balanced that a weight of 3 oz. (.1875 lb.) at ten inches from the spindle would cause the beam to vibrate through one inch at the index. When it is added that the absorbent of the power was a dynamo running through a rheostat adjustable in its resistance to the one hundreth of a h.p., and as steady as possible, it becomes apparent that the test conditions are as crucial as a dynamometer can be placed under.

Three tests were made, two with a 200 incandescent light dynamo, and one with a 24 arc-light machine.

In the first case, the current from the dynamo was varied miscellaneously, by the fluctuation of resistance due to the switching in and out of lamps, etc.

In the second case, frequent and considerable alterations of current were made by the rheostat in order to show the degree of promptness with which the autographic instrument would respond to sudden changes of power.

Diagrams 1 and 2 show the resulting autographic records in the first case, and diagram No. 3 the records of the second case. The full lines of these diagrams are fac-similes of the actual pencil trace; the vibration of the pencil, usually so inseparable from the automatic registration of power, having been overcome by using a flexible brass wire, T, for a tracer. The point of the wire pressed upon chemical paper with sufficient friction to cause the vibrations to expend themselves in the flexure of the wire without displacing the point, while permanent movements of the wire were immediately responded to by a movement of the tracing point.

In the diagrams the crosses and broken lines are plotted observations from the Brackett dynamometer.

CARRYING AND DISTRIBUTING ELECTRICAL CONDUCTORS THROUGH CITIES.

BY ELIAS E. RIES.

How to bury the present network of overhead wires in the quickest and most economical manner and with the least disturbance of the public streets, is a question which has lately been much agitated in some of our larger cities, and a number of plans have been proposed for accomplishing this end. In most cases, however, the principal thing to be taken into account in this connection has been overlooked, and that is the probable future growth in the demand for electrical service of various kinds.

It is apparent that when the present rapid increase in the local demand for electrical service is considered and when it is remembered that the various applications of electricity in their adaptation to different forms of public service are as yet comparatively undeveloped, and that the present tendency in electrical progress and practical development is in the direction of a house-to-house supply or service, the question of properly carrying and distributing the large number of conductors that will be required to supply this demand is one of vital importance, and a conduit system that does not provide for the future needs of the city in this respect will be open to very serious objection.

It is very evident that if the city streets, already overcrowded with a subterranean network of gas and water pipes, sewers and in some of the larger cities, with cable railway conduits, steam pipes for supplying heat and power, pneumatic tubes, etc., not to speak of the experimental electric conduits already laid, are given over to the various present and prospective electrical companies, they will soon become so cut up by the conduits and the distributing and service

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tubes of the different companies (granting for a moment that all the conductors can be satisfactorily and economically operated when so buried), that the streets will not only become so overcrowded and interwoven with the various underground service systems that the limit of capacity to further construction will soon be reached, but the constant tearing up of the streets for making the repairs, connections and alterations necessary in such a complicated subterranean network will cause such serious interruption and annoyance that the thoroughfares will ultimately become entirely unfit for traffic. Not only will the future growth be large from natural causes but it must be remembered that rival electrical corporations will be sure to spring up to claim a share of the public patronage as soon as the privileges and patent rights controlled by the present telephone, lighting, power, heating and other electrical companies have expired, as has heretofore been so often demonstrated in the case of gas and telegraph companies.

It is clear, then, that the only satisfactory means of attaining the required object would be by means of a single general underground conduit system designed and adapted to carry and properly distribute all electrical conductors that may be necessary. We will therefore briefly consider the requirements that are essential in a conduit system of this kind, which may be divided into two classes—practical and technical.

The practical requirements are: first, a perfect system of main, branch and distributing conduits or subways capable of supplying every portion of the city with such conductors as it may require; second, ample capacity for receiving and distributing electrical conductors of every kind that may be necessary for all present and future needs; third, suitable facilities for making repairs and connections, and for laying additional conductors without in any manner disturbing the streets or interfering with traffic; fourth, facilities for permitting thorough personal inspection of the entire interior of the main and branch conduits; fifth, economy in construction, operation and maintenance of the conduit system; sixth, comparative non-interference with traffic during the building or construction of the conduit.

The technical requirements are: first, suitable interior arrangements whereby conductors of different classes may be carried without interfering with one another; second, means for preventing leakage and induction between the various conductors of the conduit; third, means for preventing or overcoming the effects of retardation. Let us now see if these requirements can be carried out in practice.

As we have seen, to permit the different electrical companies to indiscriminately bury their wires to suit their own ideas would be extremely hazardous and will sooner or later prove seriously detrimental to the interest of the cities. The number of complete conduit systems that a city can accommodate is very limited, and if it is possible to build a single conduit system with sufficient capacity for all present and future needs it will be decidedly more preferable in every way, even though the first cost is slightly more, than to build a separate system at some future time, or to build two or more independent systems as has been suggested, for conductors of different kinds, and will save the unnecessary digging up of a great many streets.

Among the requirements necessary for a conduit system such as we have under consideration, are first, sufficient capacity to receive and carry all electrical conductors that may be required, and second, ample facilities for readily and systematically distributing these conductors, so that every part of the city may be promptly and thoroughly served with any desired class of conductors. The conduit system, moreover, must be so arranged that a wire may be carried from any one point in the city to any other point, no matter how distant or where located, *with the least possible deviation from a direct line*, and it must also provide as well for the proper distribution of conductors intended for district supply purposes.

Now, laying aside the technical difficulties that will have to be overcome in any underground conduit system, it is clear that to build a complete system of underground ways or conduits which will meet these requirements and be large enough to properly accommodate all the necessary conductors and permit of ready access for inspection, repairs, etc., is, in any of our large American cities, a practical impossibility, on account of the large number of underground works that already occupy in the most inextricable confusion all of the most available thoroughfares, and to remove and reorganize which, if not absolutely impossible at the present time, will at least be attended with such an enormous expense, and would result in such serious inconvenience and interruption to traffic that it will scarcely be attempted.

It will be seen then, that we have a very obstinate and practically insurmountable difficulty to contend with. On the one hand, if we run a large number of small subterranean conduits in every direction through the streets of our cities we only add to the confusion that at present exists in underground service systems, and increase the difficulty of laying additional tubes, pipes or conduits. On the other hand, if we attempt to construct a limited number of subways large enough to accommodate at once all the electrical conductors required, we are met at every point by the firm and immovable water and gas mains, sewers and similar obstructions. In projected cities and towns an underground system of subways, which can also be used for ordinary city service and supply purposes, can very readily be built if the money is forthcoming, which however it seldom is, while in populated cities the streets are already so occupied by the necessary drainage supply and service systems that the construction of a properly organized system of subways is practically impossible.

However, there is a simple and very effective method of overcoming this difficulty despite the obstacles that oppose the satisfactory and economical construction of an underground system. This consists in compromising upon a system of overhead or elevated main and branch ways, and underground distributing and service conduits, and it is proposed to show that this system if properly carried out, has several important advantages over any possible system of underground conduits, both from a technical and practical standpoint, and that by means of this system it is possible to overcome some of the principal difficulties heretofore encountered in operating underground conductors. It may be remarked here, however, that the system or plan of distribution about to be described is equally well adapted for a complete underground conduit system, provided the construction of such a system can be successfully carried out despite the difficulties already mentioned as opposing it.

This system comprises a main *elevated* conduit structure or way running along one of the streets or avenues, in the direction of the city's length, if the length of the city should greatly exceed its breadth, or in the prevailing direction now taken by the wires. The street or avenue selected for the main conduit structure should be if possible, in the approximate centre of the city, and run as near as practicable in a straight line throughout its entire length. This main structure is supported by a double line of tubular iron posts, somewhat in the manner of the New York elevated railways, and the superstructure or way that is intended to support and carry the electric conductors covers the entire central portion of the street or avenue, leaving the sidewalks and a portion of the street on either side uncovered.

This elevated roadway is divided through its entire length into five longitudinal parts, the object of which will be considered later. The two portions on either side of the central division are set aside for the electrical conduits, of which there are two, one for the electric light and power conductors, etc., the other for the telegraph and telephone conductors. Each of these conduits, which are completely enclosed, has a central passage extending through its entire length, said passage being large and high enough to readily

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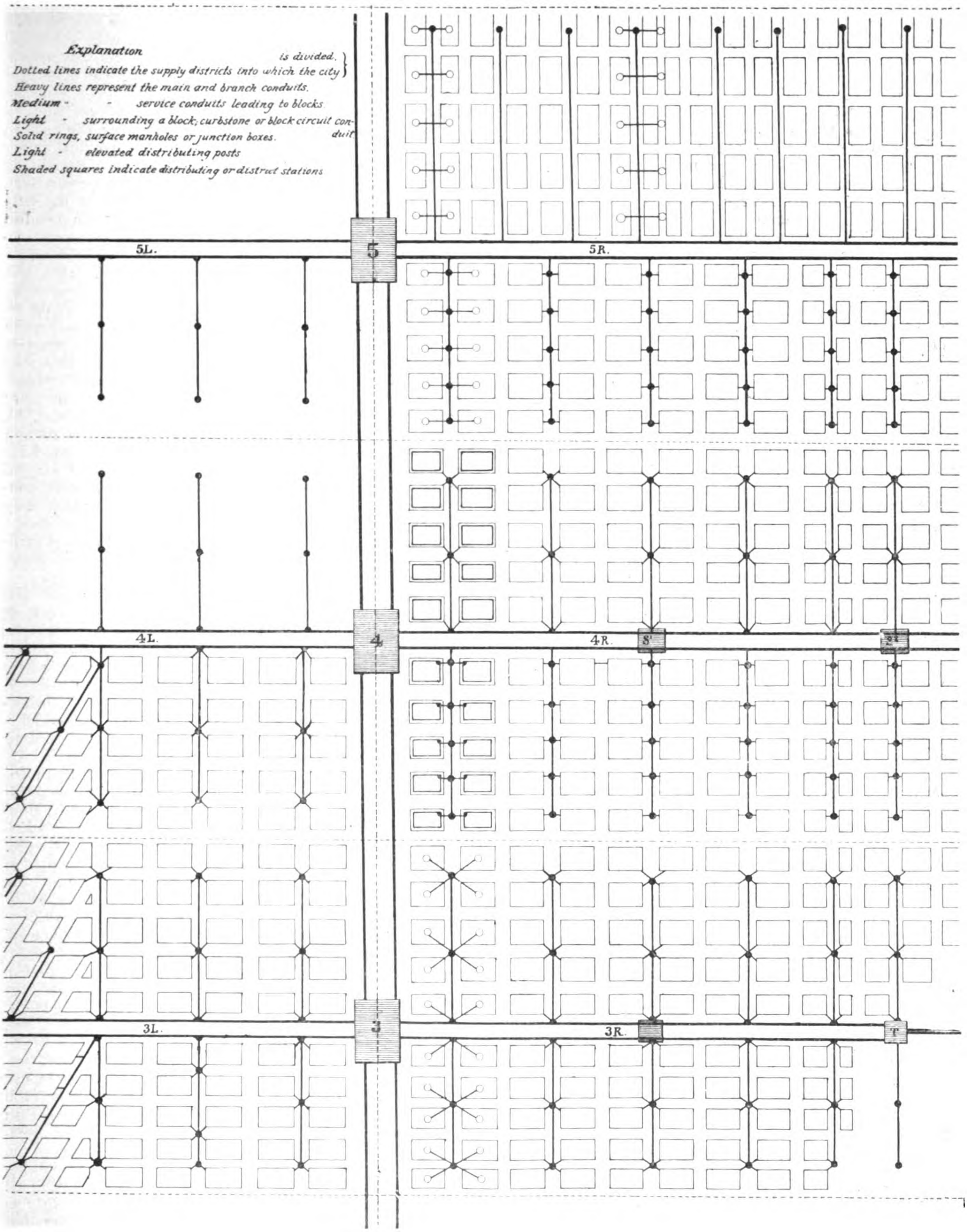

RIES'S PLAN OF WIRE DISTRIBUTION.

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admit one or more men, and is also provided with suitable racks, shelves and compartments for properly carrying and supporting conductors of different kinds. The conductors carried by the conduit are divided into classes according to the kind of current carried by them, and each class is carried independently and in separate compartments. Induction between the different classes of conductors is prevented by the iron partitions and walls of their respective compartments, which being connected with the earth at intervals by means of the tubular supporting posts and the underground distributing conduits connecting therewith, act as an induction screen or shield by receiving into their greater substance the induced currents generated by the respective conductors, and thereby prevent these currents from escaping to or affecting the conductors in any of the neighboring compartments.

At intervals of every ten blocks the main conduit is provided with a "distributing" or "district" station, at each of which an elevated branch conduit extends in opposite directions from both sides of the main structure, and traverses its respective portion of the city in a direction at right angles to that taken by the main conduit. These branch conduits are in the form of a rectangular tube, whose interior is, like the conduits of the main structure, provided with a longitudinal central passage to permit of thorough personal inspection, and a series of shelves and compartments on both sides of the central passage for holding the conductors. This tubular conduit, however, need only be constructed on one side of the street, and is supported by means of a single line of tubular posts, which are erected at proper intervals along the curb. At every alternate street along the line of the branch conduits one of these supporting posts is connected with short underground distributing conduits extending along such alternate streets for a distance of not more than five blocks on both sides of the branch conduit, through which the necessary wires or conductors are led from the elevated branches to the stations or houses located on the row of blocks between which the distributing conduits extend. The distributing conduits are provided with junction-boxes from which an underground service tube runs to an area or courtyard in the centre of the blocks facing the distributing conduits, and there terminates in a tubular upright service post from which the various conductors radiate and enter the rear end of the surrounding buildings.

This arrangement will be readily understood by referring to the accompanying plan, which illustrates a portion of a city to which this method of distribution is applied. The conduit system is shown by the black lines, the double lines representing the elevated portions, that is, the main and the several branch conduits or ways, and the smaller lines representing the underground portions, or in other words, the distributing conduits and service tubes. The main conduit, at its junction with the several branches, is provided with elevated distributing stations; 3, 4, 5, etc., which, as will be seen, are placed ten blocks apart. The city, on either side of the main conduit, is divided into as many supply districts as there are branch conduits, as indicated by the dotted lines, and each branch conduit extends directly through the centre of its respective district. These supply districts measure ten blocks in breadth, and in length extend from the central main conduit to the city limits; if however, this latter distance exceeds twenty blocks, an auxiliary conduit, either elevated or underground, should connect the several branch conduits with each other. Each district is sub-divided into a number of sub-districts, each consisting of a group of ten blocks arranged in two rows of five blocks each, between which rows extends an underground distributing tube connecting with one of the posts that support the elevated branch conduit. The connection with the several blocks is made by means of service tubes that extend from suitable junction boxes in the distributing conduits, either to an upright tubular distributing or service post in the centre or court yard of each block, as shown in the first two sub-districts of the branch 3 R and 5 R, or to a "block circuit" or "curbstone" conduit, as shown at 4 R.

It will thus be seen that by means of this system it is possible to thoroughly supply ten blocks with electrical conductors (and other classes of service as well) by means of an underground distributing conduit a little over four blocks in length, and with the use of only three junction boxes. It will also be noticed that *no individual block is in direct* connection with either the main or the branch conduits, all connections with the main conduit being through the service tube of the block, to the distributing conduit of the sub-district of which the block forms a part, to the elevated branch conduit in whose district the sub-district is located, and then to the elevated main conduit in the order named. Consequently, the supply and connections to an entire district can be governed and held under control from the distributing station of such district, and the supply to any particular sub-district can likewise be changed or controlled by means of suitable connections or cut-outs at the junction of the distributing with the branch conduit, and this can be followed down so that in case of fire or other emergency, the supply of any class of current can be cut off, or the continuity of any or all the conductors or circuits on the block preserved so as not to interfere with the supply to the other blocks of the sub-district, by means of a junction box having the necessary cut-outs and switches located on each block. The distributing conduits are not only intended to distribute the conductors carried by the main and branch conduits, but also to receive conductors from telegraph offices and other stations that may be located in their sub-district and carry them, by means of the branch conduit, to the distributing station and main conduit, from which point they run to their several destinations.

Another advantage of this method of carrying and distributing conductors is that substantially all the work of repairing, making connections and additions etc., will be confined to the elevated main and branch conduits, for the reason that they carry the burden of all the wires, cables and other conductors, and thus the streets will be relieved from the constant disturbance to which they would otherwise be subjected from this source. The underground distributing conduits, being comparatively short and holding each but a small proportion of the conductors carried by the elevated branches, would seldom be called upon for repairs, but if this should become necessary, the comparatively short length and small dimension of any individual conduit, and the facilities provided for introducing additional conductors, will render this work extremely simple. It will also be noticed, that while the *aggregate* length of electrical conductors actually under the surface of the streets is considerable, *the actual underground length of each individual wire or conductor is extremely small.*

It is owing to this fact that this system obviates one of the greatest difficulties met with in operating underground electrical conductors, and that is, retardation due to the inductive influence of the earth. It is well-known that this, more than anything else, has prevented the general burying of telegraph and telephone wires and cables, and is at the present time the greatest drawback outside of the difficulty of securing the necessary subterranean facilities, to the successful construction and operation of a *complete* underground system. In the system shown the telegraph and telephone wires are carried through the elevated main and branch conduits to a point at or very near their destination and the distribution then completed by means of the short underground conduits. It is true that the grounding of the conduit compartments for the purpose of getting rid of induction and leakage will cause them to act slightly as a retarding medium upon their enclosed conductors, but this effect, it is believed, will not be nearly as pronounced as if these conductors were buried directly in the earth or in close proximity thereto, as they would be in an underground conduit system.

Having now given a general outline of this system, and

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shown in what manner the requirements necessary to an electrical conduit system can be attained, and the technical and practical difficulties successfully overcome, we will now turn our attention to a brief consideration of other forms of service to which this conduit system is adapted, and which, although not directly affecting the electrical questions involved, would nevertheless have an important bearing in the consideration of the practical and financial side of the question, inasmuch as such additional forms of service will have much to do with the successful and economical distribution of the electrical conductors.

It has already been stated that the main conduit structure is divided into five longitudinal parts, of which the conduit enclosures occupy the two portions immediately adjoining the central division. The central division is bridged or floored over so that this flooring is level and continuous with the top of the two conduits, and is designed to be used as an elevated footway or promenade for pedestrians who may wish to avoid the crowds and traffic on the streets below. The two outside divisions of the main structure are intended for rapid transit purposes by means of electric railways, one side for up, the other for down trains, and the distributing stations will serve also as passenger stations. The central space below the footway and between the two conduits can be utilized for various other forms of service such as for tubes and pipes intended to carry and distribute compressed and rarefied air, tubes for pneumatic despatch and transmission purposes, tubes for collecting and delivering mail matter, and for an electric railway or telpherage system for transmitting packages of mail matter, newspapers, and general merchandise. These various forms of service, can be operated to and between the several districts of the city by means of the main and branch conduits, and if necessary, the compressed air and transmission tubes can be distributed by means of underground distributing conduits having separate compartments or divisions for the electrical and pneumatic conductors.

If the conduit system is intended to be employed for rapid transit or transportation purposes in addition to its function as a conduit for electrical conductors, the elevated branch conduits are built sufficiently strong to support an electric passenger railway upon the top of the rectangular conduit, suitable provision being made to prevent undue vibrations from affecting the conductors carried in the interior. The conduits are furthermore provided with stations at proper intervals, as shown at s 1 and s 2. The trains of the branch conduits run back and forth between the distributing and the terminal stations, while the trains of the main conduit structure run along the main structure from one end of the city to the other. The operation of this system of railways is such that the cars of the branch lines carry passengers from points on their respective lines to the station at their respective junction with the main line, from which station the transportation is completed by the trains of the main railway, or the passengers transferred from such station by said trains to another station the trains from which lead to the desired destination, thus enabling a passenger to be carried at will either between any two stations on any particular line, or (without extra charge) by a transfer at the main line, from any station on one line to any station on any other line. Thus by means of *a single system* of railways, operated in the manner described, a passenger may be rapidly conveyed from any desired portion of the city, no matter where located, to any other point in the city that he may desire to reach, and at the end of his trip find himself *within less than five blocks* of his destination.

From what has been said it will be seen that this system of distribution is not only adapted to thoroughly and practically distribute electrical conductors of every kind with the smallest amount of waste and in such a manner as to accommodate itself to nearly every form of distribution, but the conduit system is equally well adapted for any class of service that can be desired for city or district supply purposes. For instance, the distributing stations 3, 4, 5, etc., which are designed as general central stations for their several districts, from which the connections and the entire operation and traffic of their respective branch and distributing conduits is regulated and controlled (and which, when the conduit system is intended to be used for the various purposes to which it is applicable are three stories in height, and provided with passenger waiting rooms, station and express offices, rooms for receiving, numbering and distributing conductors, and for connecting, switching and cutting out purposes, and with junction and terminal facilities of various kinds) can also be very conveniently employed as district telegraph stations and telephone exchanges for their respective districts, inasmuch as ample facilities already exist from the manner of distribution employed in each district, and therefore, although the system of overhead and underground conduits is not exactly what has been aimed at by recent legislation, it is believed to be better adapted to the purpose from practical and economical considerations, and that it obviates difficulties that would be almost insurmountable in an underground system.

Baltimore, Md., Aug. 26, 1885.

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Continued from page 381.)

RIVER CROSSINGS.

WHEN a river is to be crossed by a telegraph, or telephone line, the first thing to be decided is whether overhead spans, subaqueous cable, or bridge, is to be employed. This will have to be determined by the surroundings. If a bridge is convenient, whether provided with a draw or not, it is well to avail ourself of its facilities. If it is a permanent structure all the way across, we may run naked wires over, on fixtures at the sides of the bridge either above or below the roadway, employing the ordinary glass insulator; or we may run a compound conductor cable containing as many wires as may be found necessary. If the bridge has a draw in the middle, it is still the preferable route; first, because the solid part of the bridge shortens the cable length, which especially in telephone lines is an important consideration; and second because in a bridge channel the cables are usually safe from the dragging of anchors.

Rivers are sometimes crossed by wires on high masts. Such a mode is not to be commended, if the river is more than a hundred yards wide, if it is a navigable stream, or if more than one wire is to be carried over. When it is done the wire should be of steel, and should be unusually well braced on each side, and the proper dip should be carefully attended to. If the banks on both sides are high, the masts need not be higher than ordinary poles.

The majority of text-books or manuals of telegraphy content themselves with describing the methods of laying, testing and operating sea cables. I propose on the contrary to give a few hints on the laying of river or short cables, as being the only ones that inexperienced persons are likely to be called upon to lay. The route must first be chosen. Of course a safe depth is not often to be found in rivers. In navigable rivers the cable always runs its chances of being dragged, but anchorage grounds are to be avoided, as also are points where the current flows with unusual strength; the best bottom for a cable in a river is mud, or silt; the only objection to sand being that it is movable, and hence apt to accumulate over the cable and to bury it, so that it cannot be raised when repairs become necessary.

If there be no choice in the bottom, the cable must be made with a view to counteract any destructive agencies found to exist at that point; for example, if the current be

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swift, a large and heavy cable is required; if a rock or stony bottom be found, the cable need not be specially heavy, but must be stoutly armored. Of course the essential elements of an electrical cable for subaqueous work are the conductor and the insulator; and inasmuch as together they are very deficient in tensile strength and as they are frequently exposed to heavy strains, besides requiring protection from the numerous destroying agencies which attack them, they are almost always provided with a strong and tenacious covering in the form of armor, laid round them in plaited strands of heavy iron wire. The conductor is invariably of copper, and the highest degree of purity should be insisted upon. The gauge of the wire if single wires are used, ought, for telegraphy, to be at least No. 14, while in the multiple conductor telephone cables No. 18 should be the minimum size.

The best cables have the conductor formed of stranded wire—either three wires twisted together, or six wires twisted round a seventh; the advantages of stranded wire being greater flexibility and increased security. When stranded conductors are ordered the manufacturer should be instructed that the several wires must break joints with one another, and that silver solder must be used at the joints with rosin as the only flux.

For cables of a mile or less, the single wire will answer very well. In the insulation of under water cables there are not many materials to choose from; for long cables I should prefer to stick to the well tried gutta-percha or india-rubber; while for ordinary river cables either of the above, kerite well served with tarred hemp, and armored, or lead pipe paraffined cable, served over the lead with hemp or soft rope and armored, answer well. If any lead pipe cable is to be used under water great care must be taken in testing it before laying for pin holes in the lead. As many as fifty conductors may be embodied in a telephone cable if they are well insulated. A sufficient degree of slack must always be allowed for, and more in proportion is required with short cables than with long.

In ordering the cable it is well to specify a larger number of conductors than there are land lines to connect with, both to allow for the expansion of the system and also to allow a few spares in case any conductor should be damaged. There is considerable difference of opinion about the amount of slack which should be allowed when laying. I think, however, that in most cases slackness is to be preferred for several reasons: In the case of rivers, which scour the bottoms, or in shallow water where the cable is liable to injury, the slack is obviously useful; where, however, the banks and bed are stable and the risk from anchors is small the cable may be tightened up pretty well, taking, however, the precaution of burying several feet of cable at each end in a coil between the cable box and the river. This is useful where the cable has to be afterwards spliced, and also helps out, if the cable is attacked by lightning, as the fault due to a lightning discharge would most likely occur inside of twenty-five feet from the end of the cable at which the electricity entered. Of course when a regular telegraphic organization lays a sea cable, or a cable across an estuary or arm of the sea, it usually is provided with a vessel adapted for the purpose, together with experienced workmen, and all the necessary tools and appliances for the purpose.

When a smaller concern has a cable to lay, the location is generally a stream crossing, and the requisite facilities are not ordinarily so well supplied. Furthermore, the expense of procuring a suitable vessel is too great compared with the importance of a single cable. In these circumstances if the water is navigable, and both wide and deep, the best thing to do is to procure a steam tug on which the reel is placed, and to pay the cable out therefrom. A steam vessel is much better than a sailer, because being independent of the wind she can go in an approximately straight line from point to point. In a wide stream the terminal points on both sides can be designated by a pole or flag to guide the course. This is particularly necessary if smaller boats are used. If the water is not navigable, or if the tug cannot be procured, or if the stream is very narrow, a large rowboat may be employed, but this involves greatly increased labor. Although as a rule the reel is placed on the deck of the vessel, the free end being fastened firmly on the shore, it is quite conceivable that circumstances may arise in which this procedure cannot be adopted and in such circumstances alternative methods must be employed.

The reel may be firmly fixed on the river shore, and a rowboat well manned may be used to carry the free end over; the reel must in that event be managed by a part of the force, so as to reduce the strain on the boat. I have even known of occasions where there were no facilities at all to cross a comparatively shallow river, and where the cable was absolutely carried over the stream by a few men and then sunk.

Another way is to suspend a strong steel wire from bank to bank and use it as a suspending wire on which to carry the cable over on pulleys, sliding sleeves, or sheaves; after getting over it is very easy to drop it into the water. These expedients are only applicable of course to narrow rivers or watercourses. When narrow but deep water has to be cabled, the cable while being laid sometimes develops a wonderful tension, and if this increases to such a degree that it cannot be directly controlled, a single turn of it may be passed round a drum, and friction can then be applied to the drum by which the speed may be controlled. This is but a crude expedient but serves well enough for a short cable. Another way is to pass the cable between two blocks of wood, pressed together by leverage. It is never safe to start on a laying expedition without some means of controlling the speed and tension of the cable. In all cases the greatest care is essential to prevent kinks.

In tide water, or in rivers where there is much difference between high and low water, both cable ends should be well buried out to the mark of low water and covered with heavy planking weighted or otherwise fastened down, as nothing is worse for a cable than to be exposed to the atmosphere and sun. The connection between the cable conductor and the land line ought uniformly to be made in a cable box which should always be made water tight, and which should be attached to a pole some distance back on the shore or bank so as to be out of the reach of ordinary high water. Cable boxes at bridge draws can be attached to the first wire support at both sides of the draw. The cable must be brought to the pole in a well covered trench and led up to the box, entering it at the bottom and between the trench and cable box, must be firmly spiked or stapled to the pole, so that if the waters should rise and float the pole it will act as a buoy for the cable. From the foot of the terminal pole to the cable box a troughing is secured to the pole to protect the ascending cable, and the cable enters by a hole at the bottom of the box. The land lines come to the pole and are dropped from their insulators at the top to other insulators just above the box at which they are terminated. A well insulated wire is attached to each, and is led into the box through padded holes, the connection between it and the cable conductor being made within the box.

No cable should be left without a lightning arrester at each end, which is also placed in the box; as a ground wire for this arrester there is nothing better than the cable armor itself. The cable end may be stripped of the armor about a foot before it enters the box, and the insulator conductors brought in together and separated inside.

Solder the splice and then cover it with rubber or kerite tape. The two wires are sometimes joined by a screw connector, but this is not advisable as the screws will work loose, and the metal will oxidize.

It is far better to make a permanent splice connection, covering it as described and to run a branch wire to the arrester.

(*To be continued.*)

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EXPERIMENTS WITH THE THERMAL TELEPHONE [1]

BY CHAS. R. CROSS.

In the *Telegraphic Journal* for 1880, page 204, Mr. Wm. H. Preece describes some very interesting experiments with a new form of telephonic receiver, consisting of a fine stretched wire, one end of which is attached to the middle of a diaphragm and the other to an adjustable support. The wire is placed in circuit with a voltaic battery and a microphone. When the microphone is actuated by the voice, the electrical undulations thereby produced in the battery circuit cause corresponding variations in the temperature, and hence in the tension of the wire, and thus the diaphragm is set into vibration so that speech is reproduced.

Mr. Preece used six "bichromate of potash" cells. He does not state the amount of the heating effect on the wire, but from what is said it is evident that the temperature of the wire was but slightly elevated.

The statement of results in the paper referred to is quite brief, and the experiments detailed below were undertaken in order to ascertain to what extent speech can be reproduced by such a receiver, both as to loudness and intensity; to study somewhat further the changes due to variation in the length and diameter of wire of different materials, under varying conditions of current strength; and, especially, to observe the effect of varying the temperature of the wire. Most of the experimental work has been carried on under my direction by Messrs. W. J. Hopkins and J. O. Ellinger, students in the laboratory of the Massachusetts Institute of Technology.

We first sought to find under what conditions we could realize the maximum loudness of speech, using platinum wire which had given the best results with Mr. Preece. For a transmitter we used a Hunning microphone, a form of transmitter in which granulated carbon is employed, the powder being loosely confined between two metallic plates. The battery used consisted of from one to twelve Grenet cells, the maximum current used being sufficient to raise the temperature of a platinum wire, .01 in diameter and about 10 inches long, to redness. In order to avoid excessive heating of the transmitter, it was placed in derived circuit with the battery and receiver. In some experiments, the diaphragm was made of firm cardboard, and in others of sheet iron.

One would naturally suppose that the larger the wire the greater would be the variations in tension and hence the greater the loudness of the resulting sound. If, however, the length of the wire is increased beyond a certain limit, the quality of the articulation appears to become very inferior, even though the loudness may be somewhat increased; and the wire tends to assume a free vibration of its own, producing a confusing after-tone.

The heaviest wire that we used was 0.0095 inches in diameter, as want of the requisite current at the time of the experiments prevented our increasing the diameter beyond this. With it a length of about 6 inches gave in general the maximum loudness, as Mr. Preece had previously observed.

Using a platinum wire .004 in. in diameter and from 6 to 7 in. long, with sufficient current to raise its temperature to dull redness, very remarkable results were obtained. Not only could the most unfamiliar conversation be understood, but words spoken into the transmitter were heard and understood with the ear at a distance of from 2 to 10 inches from the diaphragm of the receiver, the character and loudness of the sound being very similar to that obtained when a Hunning transmitter is used with an ordinary magneto receiver. Using a somewhat shorter wire at the same temperature, gave a decidedly better quality of sound, but the loudness was very materially diminished. Lowering the temperature caused a rapid diminution in the loudness of the sound.

1. Read at a meeting of the American Academy of Arts and Sciences, Oct. 14, 1885.

Almost as good results were obtained with german silver wire, a material not mentioned by Mr. Preece; but with this the influence of temperature was far less marked than in the case of platinum. In fact, quite as good results both as to loudness and distinctness of articulation, were obtained when the wire was simply warm to the touch as when it was hotter. In this respect german silver differs from any of the other materials that we used. With iron and copper but few experiments were tried, and the results were quite unsatisfactory.

It is difficult to give any numerical estimate of loudness and distinctness in such experiments as these. The following tables, however, besides furnishing a more precise idea of our results, will show the result reached in some attempts to form a numerical estimate of the relative intensity under different circumstances. The loudness of an ordinary magneto receiver when used with a magneto transmitter, spoken into with a moderately loud tone of voice, is called 10.

GERMAN SILVER WIRE, DIAMETER .007 IN., JUST BELOW REDNESS.

Length.	Nature of Articulation.	Comparative Loudness.
10½ in.	Faint, but distinct	8
7½ "	Clearer	7
5 "	Same as in last experiment	8
3 "	Poor and indistinct	4

PLATINUM WIRE, DIAMETER .0095 IN., AT RED HEAT.

10½ in.	No sound	0
7½ "	Very faint	1
5 "	Quite distinct speech	4
3½ "	No sound	0

PLATINUM WIRE, DIAMETER .006 IN., JUST BELOW REDNESS.

10½ in.	Distinct	Fairly loud.
7½ in.	No change in distinctness	Loud as magneto.
6½ "	" " " "	Louder.
4½ "	" " " "	Much fainter.
2½ "	Very indistinct	Barely audible.

NOTE.—In the last experiment the wire was cool when the shorter length was used.

PLATINUM WIRE, DIAMETER .005 IN., JUST BELOW REDNESS.

7 in.	Speech easily understood	Moderately loud.
5 "	Clearer	" "
3 "	Fairly distinct	Fainter.

PLATINUM WIRE, DIAMETER .004 IN., JUST BELOW REDNESS.

10¾ in.	Speech fairly distinct	Faint.
7½ "	Very distinct	Much louder.
3½ "	Clear	Less loud.
2½ "	"	" "
1¼ "	No sound	Inaudible.

PLATINUM WIRE, DIAMETER .002 IN., JUST BELOW REDNESS.

5 in.	Fairly distinct	5
3 "	Less distinct	9
1¼ "	No sound	0

From these and other experiments, it appears that our best results were obtained with the wire of .006 and .004 in. in diameter, there being but little difference between them. The largest wire used (.0095 in. diameter) gave very poor results, and with the battery power used by us the finest wire employed (.002 in. diameter) was equally inefficient. Mr. Preece's best results were secured with platinum wire, .001 in. in diameter. Also with the finer wire the most effective length was less than with the larger sizes. The most interesting point, however, developed in the course of our experiments is the effect of increasing the temperature, notably with platinum wire, in increasing the loudness of articulation of the thermal receiver. This will naturally be attributed to the greater expansibility of the wire at high temperatures. It is possible that with german silver the effect, good at moderate temperatures, is not bettered on heating the wire, because of a marked influence of temperature in diminishing its elasticity.

The question also suggested itself as to what effect, if any, would be produced if the microphone were placed in the primary circuit of an induction coil, and the wire receiver in the secondary circuit, so that the receiver would

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only be acted upon by the induced currents from the coil. Since the heating effect varies as the square of the current, with such an arrangement difference of sign in the current could not be perceived at the receiver, and therefore one would not expect to be able to distinguish articulate speech. We thought that if any sound was produced it would be interesting to study its quality as compared with the quality of the sound actuating the transmitter. Our results, however, were negative. A sound was produced on breaking the circuit, but no audible effect was observed on speaking or shouting into the transmitter. In these experiments german silver wire was used in the hope that even at ordinary temperatures it might prove sensitive. Independent heating by a current of hot air was tried, but without success.

An attempt was also made to use the thermal telephone as a transmitter. Sir Wm. Thomson has shown in his researches on the electro dynamic qualities of metals (Math. and Physical Papers, vol. ii., p. 208), that the electrical resistance of wires is varied by their tension, and indeed it was in following out this idea that Prof. Hughes was led to his invention of the microphone (*Telegraphic Journal*, May 15, 1878).

Slight as the variation in resistance must necessarily be with such a transmitter, we yet hoped that the exceeding sensitiveness of the magneto receiver would suffice to detect it. Our results, while not at all striking, were sufficiently encouraging to lead us to hope for greater ultimate success. The thermal telephone, with a platinum wire 4½ in. long and 0.004 in. in diameter and an iron diaphragm, was placed in circuit with a battery of 10 Grenet cells and an ordinary hand telephone receiver. The current was sufficient to heat the wire almost to redness. All the joints of the wire were soldered to prevent the possibility of microphonic action, which at first caused some annoyance, but which was readily recognizable by the scratching sound produced by it. With the joints thus soldered, and every precaution taken to avoid such microphonic disturbances, we succeeded in hearing and understanding at the receiver the word "hallo," and some brief familiar sentences. The sound was low but distinct and clear, and in quality quite unlike the sound produced by microphonic action. There seems to be no doubt that electrical undulations were produced in the circuit by variations in the stress to which the heated wire was subjected. Similar results were obtained with a smaller number of cells, even down to one, but the sound was then exceedingly faint and scarcely audible. Speech was also transmitted by a thermal transmitter in which german silver wire was substituted for the platinum. It may be that the more marked results on heating the wire to a higher temperature by the use of a stronger battery indicate that at such a temperature the electrical effect of changes in stress in varying the resistance of a wire is increased.

Mass. Inst. of Technology, June, 1885.

[NOTE.—During the discussion that followed the reading of the foregoing paper, Prof. A. E. Dolbear stated that he had experimented with the thermal telephone receiver as early as 1878, using a few gravity cells, and transmitting speech audibly, though very feebly.—C. R. C.]

MEASUREMENT OF THE STRENGTH OF TELEPHONE CURRENTS.[1]

BY CHAS. R. CROSS AND JAMES PAGE.

So far as is known to the authors of the present paper no measurements have ever been made of the strength of such telephone currents as are actually used in the transmission of speech. The few figures that have been given are estimates rather than measurements. Some very interesting results are given by Dr. C. J. Blake (*Jour. Soc. Tel. Engineers*, 1878), regarding the logographic values of the different vowels as determined by the throw of the needle of a mirror galvanometer used in connection with a magneto transmitter. This logographic effect, however, should be carefully distinguished from that of the alternating currents utilized in the continuous transmission of sound, as, even with apparatus suitable for the measurement of such currents, it is liable to mask the phenomena to be studied unless care be taken to avoid such disturbing effects.

The lack of figures in so interesting and important a subject as the one under consideration, arises from the fact that an electro-dynamometer of some form must be used for the necessary measurements, and an exceedingly sensitive instrument is essential in order to obtain sufficient deflection to give results of any value.

A form of electrical balance similar to that figured by Maxwell (*Electricity and Magnetism*, 2d ed., vol. ii., p. 342) was at first constructed, but this failed to give satisfactory results. Subsequently, success was obtained by using a Kohlrausch unifilar electro-dynamometer, made by Hartmann, of the form described in Wiedemann's *Annalen*, vol. xv., 1882, p. 550. The instrument was modified by removing the heavy movable coil, furnished by the maker, which was of altogether too low resistance for our purpose, and replacing it by a lighter and closely wound coil of No. 36 (B. and S.) copper wire with a suspending wire of the same gauge and 40 centimetres in length. The resistance of the instrument was 206 ohms, that of the suspended coil being 166 ohms. In some of the experiments the metallic vane which, in the instrument as described by Kohlrausch dips into a vessel of dilute sulphuric acid, was removed, and a needle point dipping into mercury substituted, the connection with the telephone being made through this. But the greater freedom from disturbances when the vane was used made it preferable. The rapid alternation of current prevented any difficulty from polarization, as was shown by the fact that with a source of sound of constant intensity the same results were obtained whether dilute sulphuric acid or mercury was employed. A reading telescope and scale graduated to millimetres served to determine the deflections of the dynamometer coil, the telescope being at a distance of 1.5 metres from the mirror.

The dynamometer was usually placed in the secondary circuit of a small induction coil, the resistance of which was about 800 ohms. The microphone transmitters were placed in the primary circuit, with two Grenet cells arranged in parallel circuit. When the magneto transmitter was used it was placed directly in circuit with the electro-dynamometer.

The dynamometer was so placed that when no current was flowing the axis of its suspended coil was at right angles to the magnetic meridian. No special pains were taken to secure this accurately, as the action of the deviating couple due to the earth's magnetism was found to be quite negligible in comparison with variations caused by unavoidable differences in the intensity of the sounds acting upon the transmitter. Deflections of the suspended coil were read by the use of a mirror, telescope and scale, as the ordinary method of bringing the scale-reading back to zero by moving the torsion head of the instrument could not be used, since it was impossible with the voice to sustain a note for a sufficient length of time. The deflections were therefore read by the observer, and the strength of the current subsequently determined from these by the following method: A Daniell cell was placed in circuit with the dynamometer, using a mercury contact to avoid the polarization which would ensue with dilute sulphuric acid, and by means of a rheostat interposed in the circuit the resistance was varied until deflections were obtained corresponding with those given by the telephone currents. The electromotive force of the cell divided by the total resistance in the circuit gave the current corresponding to any given deflection. A galvanometer was also inserted in the circuit, but as there was some uncertainty about its

1. Read at a meeting of the American Academy of Arts and Sciences, Oct. 14th, 1885.

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constant and law of deflection which we were prevented from determining by want of time, the method already stated was relied upon, merely using the figures given by the galvanometer as a check upon the results. The current strength as given in this paper is therefore the strength of the steady current, which gives the same dynamometer reading as the alternating currents of the telephone. No correction for the self-induction of the dynamometer was attempted, as the range of variation in the readings shows that at the present stage of our research no real increase in accuracy would be secured by doing this.

The absence of any means of obtaining a definite and constant intensity of the voice renders it very difficult to obtain uniformity in results. Care was, however, taken not to continue the experiment very long at any one time, as the voice of the singer or speaker became wearied and was less under control.

In telephonic experiments care must be taken, as already intimated, to avoid the logographic disturbance that arises from the strong air pressure developed on beginning the utterance of different sounds, as the magnitude of the temporary deviation produced by this often far exceeds the permanent deflection which is given by the continuous telephone current. This can be done by raising the voice very gradually, but a better method, which we have employed, is to interpose a key which keeps the circuit open until the sound is fully developed. Then on closing the circuit, the deflection quickly becomes steady, and the disturbance in question is avoided.

Measurements were made with the Hunning, Fitch, Blake, Edison and Bell magneto transmitters. The Hunning transmitter uses carbon in a granulated form, and the Fitch employs two hard carbon discs as electrodes. The structure of the other transmitters is too well known to require any description.

The vowels *a*, *o*, *u*, *i* (German sounds), were spoken or sung into the transmitter successively, all at the same pitch, viz.: the B of 480 vibrations, and with the same intensity as nearly as this could be realized. The deflections obtained are given below in full, in order to furnish some idea of the degree of uniformity obtained. Several separate series are given for each transmitter. In some cases the loudness of the voice varied somewhat in passing from one series to the next.

The readings are given in centimetres and tenths.

Some experiments were also made upon a Dolbear electrostatic receiver in circuit with a Hunning transmitter and high resistance induction coil. The currents produced when speech was readily transmitted and reproduced by the Dolbear receiver were too slight to be measured by the dynamometer, although amply sufficient to reproduce speech in a magneto receiver interposed in the circuit.

HUNNING TRANSMITTER.

	a	*o*	*u*	*i*
(1)	8.0	17.5	7.0	1.7
	7.5	12.2	7.0	1.3
	7.3	15.2	8.0	1.8
	9.2	12.3	8.4	1.8
	7.4	12.5	7.9	1.9
(2)	11.5	15.5	9.8	4.0
	15.0	30.0	10.0	3.7
	15.0	20.5	11.0	3.5
	14.0	17.0	10.0	3.5
	12.5	18.5	11.0	3.0
(3)	10.0	12.5	6.5	1.5
	10.0	11.5	7.5	2.0
	13.0	15.0	8.0	2.5
	11.5	12.5	5.0	2.5
	10.1	12.4	7.0	2.2
(4)	12.5	13.0	8.0	2.0
	10.5	15.0	7.2	3.0
	12.5	15.0	9.0	2.5
	12.5	16.0	8.9	3.5
	12.0	16.0	8.7	3.5

FITCH TRANSMITTER.

	a	*e*	*u*	*i*
(2)	7.5	9.5	7.5	4.0
	5.5	9.0	7.0	4.0
	6.5	9.0	4.2	1.7
	5.0	6.5	7.0	4.5
	5.5	6.7	6.4	4.2
(2)	6.2	8.0	5.7	1.8
	6.5	7.4	5.5	0.8
	5.0	7.4	5.4	3.8
	5.4	7.7	5.4	2.7
	6.5	7.0	6.0	2.0
(2)	6.0	7.4	6.1	2.1
	6.2	9.0	6.0	3.0
	6.4	8.2	5.5	2.7
	5.4	8.0	5.5	2.4
	5.7	8.0	6.2	3.2

BLAKE TRANSMITTER.

	a	*o*	*u*	*i*
(1)	0.5	0.3	0.2	0.0
	0.4	0.7	1.8	0.1
	0.4	0.8	0.4	0.0
	0.3	0.7	0.4	0.0
	0.4	0.7	0.3	0.0
(2)	0.3	0.7	0.3	
	0.6	0.7	0.4	
	0.6	1.2	0.3	
	0.4	1.0	0.5	
	0.5	0.8	0.3	
(3)	0.5	0.8	0.4	
	0.6	0.8	0.3	
	0.5	0.9	0.3	
	0.5	0.6	0.6	
	0.7	0.8	0.7	

EDISON TRANSMITTER.

	a	*o*	*u*	*i*
(1)	0.3	0.4	0.8	00.2
	0.8	0.5	1.1	0.1
	0 3	0.7	0.8	0.1
	0.2	0.7	0.7	0.1
	0.3	0.5	0.7	0.3
(2)	0.3	0.5	0.7	0.1
	0.2	0.7	0.8	0.1
	0.2	0.7	0.8	0.2
	0.2	0.6	0.4	0.1
	0.1	0.7	0.3	0.2
(3)	0.4	0.9	0.5	0.1
	0.2	0.7	0.5	0.1
	0.2	0.8	1.1	0.2
	0.3	0.7	1.2	0.2
	0.4	0.8	0.8	0.3

BELL MAGNETO TRANSMITTER.

	a	*o*	*u*	*i*
(1)	0.4	1.2	0.8	0.1
	0.3	1.3	2.3	0.8
	0.6	4.0	3.6	0.3
	0.4	2.9	5.4	0.5
	0.3	2.0	3.4	0.2
(2)	0.7	1.0	2.1	0.2
	0.4	1.2	2.0	0.3
	0.6	1.3	2.0	0.7
	0.6	2.2	3.2	0.7
	0.8	2.7	2.7	0.5
(3)	0.6	3.1	2.2	0.4
	0.6	2.7	2.3	0.3
	0.3	2.2	1.9	0.3
	0.6	2.3	2.4	0.5
	0.7	2.5	2.2	0.2

At first sight some of the results given in the preceding tables are quite unexpected. Thus in some cases the magneto transmitter gives as great or even a greater current than the Blake carbon transmitter, although as used in actual practice the latter is far louder. This probably comes from the fact that with the magneto transmitter the lips were habitually placed close to the mouthpiece of the instrument, so that even if the same actual strength of voice was used the effect on the diaphragm of the magneto was greater than on the diaphragm of the Blake transmitter. It was impossible to use the same loudness of voice with the lips close to the mouthpiece of the latter transmitter, as the scratching sound which always appears with a microphone too strongly excited became very marked. We therefore, while keeping the voice at the same intensity, removed the mouth farther from the transmitter until the scratching ceased. In fact, the difference in the size and shape of the mouthpieces of the different instruments and the position of the mouth in speaking, whether pressed against the mouthpiece or at a little distance from it, always affect both the absolute and relative strength of the vibrations of the diaphragm with different vowels, and hence, of the resulting currents. A further interesting illustration of this will be seen by comparing the results with the Hunning and Edison transmitters.

In another series of experiments the sound of a C_4 stopped organ pipe giving 512 vibrations per second was substituted for the voice. Very great constancy in its intensity was secured by blowing it with a blast and using a very large bottle as a pressure regulator. Three tubes were inserted through the cork of the bottle. Through one of these the air from the blast entered the bottle; through a second it passed to the organ pipe; while the third tube was drawn to a small aperture at its extremity which allowed a greater or less quantity of air to pass out, according as the pressure from the blast tended to increase or diminish. Observations were made at intervals for ten

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minutes. Only slight oscillations of the coil occurred during this time. The following are the mean readings with different transmitters:

Hunning........7.9 Blake..............0.7 Magneto.........0.5
Fitch............3.4 Edison...........0.2

The strength of the current in ampères in the different experiments was as follows:

VOWEL SOUNDS.

HUNNING TRANSMITTER (from Series 3).

Vowel.	Mean Deflection.	Current.
a	10.9	0.000737
o	12.8	0.000787
u	6.8	0.000503
i	2.1	0.009213

FITCH TRANSMITTER (from Series 3).

Vowel.	Mean Deflection.	Current.
a	5.9	0.000450
o	8.1	0.000548
u	5.8	0.000442
i	2.7	0.000264

BLAKE TRANSMITTER (from Series 3).

Vowel.	Mean Deflection.	Current.
a	0.6	0.000123
o	0.8	0.000144
u	0.5	0.000114
i	...	....

EDISON TRANSMITTER (from Series 1).

Vowel.	Mean Deflection.	Current.
a	0.3	0.000068
o	0.6	0.000123
u	0.8	0.000144
i	0.2	0.000072

MAGNETO TRANSMITTER (from Series 2).

Vowel.	Mean Deflection.	Current.
a	0.6	0.000123
o	2.6	0.000260
u	2.2	0.000238
i	0.4	0.000103

SOUND OF C_4 ORGAN PIPE.

Transmitter.	Current.
Hunning.........	0.000550
Fitch............	0.000361
Blake............	0.000132
Edison...........	0.000072
Magneto.........	0.000114

In the case of some of the very small deflections observed, the current was calculated on the assumption that the deflection varied as the square of the strength of the current.

A few preliminary experiments were made, using a method by which we hope to obtain further results. A Thomson quadrant electrometer was used with the telephone on the same plan as that originally suggested by Joubert for its use with dynamo machines, giving alternating currents. The needle and one pair of the quadrants were connected with one terminal of the telephone, and the other pair of quadrants with the remaining terminal. There was not sufficient time at our disposal to obtain any series of measurement by this method, but results were reached which give encouragement as to its availability. It is possible that this method may prove especially useful in the study of electro-static telephones.

The results given in the preceding pages are to be regarded only as preliminary to a more extended series of measurements. But while they are yet necessarily somewhat meagre, they seem at least to show: first, that an electro-dynamometer of a simple construction is sufficient not merely to detect but also to measure telephone currents; and second, that the strength of these currents, especially when good carbon microphone transmitters are used, is far in excess of what has hitherto been supposed.

Mass. Inst. of Technology, Boston, June, 1885.

THE ACTUAL CANDLE POWER OF ARC LAMPS.[1]

BY J. S. ADAMS.

THE laws of light, involving as they do the principles of the higher mathematics, are not generally understood, especially those pertaining to the lighting of large areas by electricity. But in view of certain strictures upon the present system of street lighting in Elgin, made by a prominent alderman, we give the following words of explanation, which, without technicalities, will be generally understood. The only object in writing this article is to place the electric system in its true light before the people of Elgin.

In every city where the electric light has been introduced hundreds of persons seeking for facts, and unable to convince themselves that the light from the so-called 2,000 c. p. electric lamp is equal in quantity to that from 2,000 standard sperm candles, burning at the rate of 120 grains each per hour, have asked from persons whom they supposed to be able to impart the desired information: "What is the actual candle power of the light from an electric arc lamp of 2,000 nominal c. p.?"

In consequence of the lack of reliable data upon this subject, the parties questioned have not generally been able to give any positive answer to this question; but it has been admitted by well informed advocates of the electric light that the actual average light from these lamps is from 500 to 1,000 c. p.

"Why, then, are they named 2,000 c. p. if they do not give an actual average of 2,000 c. p. of light?"

In answer to this question it may be said that electric arc lamps, in common with many other articles, animals and persons, have received their titles in consequence of their best possible, instead of their average, performances.

One of these lamps tested by a photometer, under the most favorable conditions, will at times show from 2,000 to 2,200 c. p., and from this fact it has received its name or title—a 2,000 c. p. lamp—and by this name it is known throughout the civilized world.

"But this does not answer the original question: What is its actual average candle power?"

In answering this question, and in understanding the answer, it is necessary for us first to understand that the light from an electric arc lamp is not radiated in nearly equal quantities at all angles above and below the horizontal plane, like light from the ordinary lamp or candle, but that in consequence of the formation of the electric arc in the concavo-convex space between the ends of the upper and lower carbons, a large proportion of the light is projected in the form of a cone below the horizontal plane of the lamp, the most powerful rays being at an angle of 45 deg. The candle power of the light from the same lamp, and at the same moment of time, is therefore materially different when measured at different angles below the horizontal plane of the lamp.

This fact is clearly demonstrated in the following table, which gives the results of a series of photometrical measurements made at the Philadelphia electrical exhibition, and shows the intensity of the light from a Van De Poele electric lamp of 2,000 nominal c. p., at different elevations, noted at intervals of five degrees, from 0 to 60 deg.:

Elevations.	Candle power.
0 deg	450
5 deg	525
10 deg	620
15 deg	710
20 deg	805
25 deg	920
30 deg	1040
35 deg	1180
40 deg	1290
45 deg	1340
50 deg	1290
55 deg	1020
60 deg	675

Average candle power, 913.

"According to the above figures we find that the actual average candle power of these lamps is only 913, instead of 2,000; are not the people being defrauded to the extent of this difference?"

A statement of the quantity and relative cost of the light formerly in use as compared with the electric light

1. Elgin *Daily News*.

will enable the people to judge for themselves of this matter. Previous to the introduction of the electric light, there were in use in the city of Elgin 105 gas lamps, of 16 c. p. each, making a total of 1,680 c. p. of gas light, and 1,770 of naphtha, or a grand total of 3,450 c. p. of light. There are now in use 33 electric lamps of 913 c. p. each, a total of 30,129 candles; more than eight and one-half times as much light as was formerly furnished by the gas and naphtha lamps. The gas lamps were formerly extinguished at or near midnight. The electric lamps are kept burning until morning, that giving fully double the time of the former service, and thus doubling the quantity of light furnished, making the proportions more than 17 of electric light to one of gas and naphtha combined. For the former service of gas and naphtha lighting, the city paid an average of $455.61 per month. For the present electric light service the city is paying the sum of $666.66 per month, or 46 per cent. more than they paid for gas and naphtha. An extra cost of 46 per cent. for the lighting of a very much larger area, and the furnishing of more than 17 times as much light, does not appear to be a very bad bargain for the city. The photometrical measurements of the light from the different lamps exhibited at Philadelphia, have answered not only the question of the actual candle power of these lamps, but have also demonstrated the great economy of the use of the electric light, and the wisdom of the city government in its adoption.

CYLINDER ARMATURES.

BY CARL HERING.

If a continuous insulated wire be wrapped around a cylinder lengthwise, the cylinder being turned on its axis slightly after each turn of the wire (as indicated by its numbers 1 to 16 in fig. 1), and if the end of the wire be

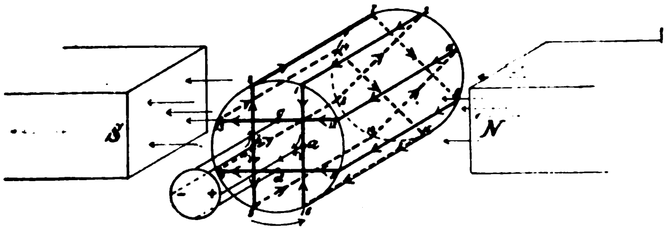

FIGURE 1.

soldered to the beginning, it will be the simplest form of a cylinder armature. If this be revolved between a north and south pole, or in a magnetic field, as it is called, currents will be induced in all the wires as they pass near the poles, and from the nature of the winding they will be found to add up to two distinct currents. From the well-known laws of Ampère and Lenz, the direction of these currents can be determined; but as it is very easy to make a mistake in applying these laws to dynamo machines, the following more simple rule used by the author may be found preferable. The direction of the lines of magnetic force is generally represented as coming out of the north pole and into the south pole.[1] Now, in looking at the commutator end or front end of the armature, *if the armature be rotated opposite to the hands of a watch, the currents on that end of the armature will go in the same direction as the lines of force.* In fig. 1 the currents, according to this rule, will flow from 12 to 13 and from 5 to 4. By following these wires we see that the currents on the side toward the north pole flow from the back to the front of the armature, and, of course, in the reverse direction on the side toward the south pole.

Placing arrows on all the wires on the curved surface of the cylinder and beginning at No. 1 for instance, we find that the currents all add up as we go around until we come to a point, *b*, where it meets a reverse current. If we start at 16 and follow the current around to 15, 14, etc., we come to the same point, *b*, showing that in two halves of the endless wire the current is induced in two opposite directions, or in other words, two halves of the armature are in multiple arc, like two batteries in which the carbons are connected together as one pole and the zincs as the other. The points *a* and *b* are therefore the two places where the currents must be taken off. These and all similar points, *c* and *d*, which come into this position during a revolution, should therefore be connected with the commutator strips against which the fixed brushes rub to lead off the current. *a* will be the positive pole and *b* the negative. Each wire of the armature will have to carry only half of the current which the machine gives, while the total electromotive force will be produced by half the number of turns on the armature.

There are a number of different methods of winding a cylinder armature, all like the above in principle but differing in details, owing to certain difficulties to be overcome. The principal one of these difficulties is due to the fact that as the two halves of the armature are in multiple arc or parallel circuit, it is very necessary that the same electromotive force should be induced in both halves, otherwise when the circuit is open the excess of electromotive force of one half over the other will cause an internal current to circulate in the armature wires and will therefore absorb work when no current is required in the external circuit. As the electromotive force depends only upon the number of lines of force cut per second, it can be kept the same in both halves by wrapping the coils so that the two halves shall have the same mean radius, that they shall have symmetrical positions with respect to the axis, and shall always be in the same or in similar parts of the magnetic field. It is also very desirable to have a "balanced" magnetic field, that is, one which is the same size, shape and magnetic density at the north as at the south pole. Owing to iron baseplates, bearings, etc., the field is frequently unbalanced, but for many systems of winding it is not essential to have it balanced, as it affects both halves alike. This is one of the advantages of the cylinder armature over the Gramme, as in the latter the unbalanced field cannot be eliminated by the winding.

As the difference of potential[2] at the ends of the two halves of the armature wires which are in multiple arc depends not only on the electromotive force of the coils, but also on the resistance of the two halves, these resistances should be equal, or what is the same thing, the lengths of the wires of all the coils should be equal. As the coils cross each other at the two ends of the armature, a so-called "head" is formed there, which grows larger for each coil, so that the last coils will always be somewhat longer than the first. In a well designed armature this difference is very slight. The armature should not be too short as compared with its diameter, and a method of winding should be selected which has as few wires crossing each other as possible, so as to make a small head on the armature.

Another important point to be remembered in winding armatures is the continual short circuiting of from one to four coils. Each brush has to be thicker than the insulation between the commutator strips in order not to break the circuit while it is passing from one to the other; at that moment it touches two commutator strips,

1. This is the direction which would be indicated by a compass needle with an arrow head on its blue or north seeking end. Lines of force have no one direction of action such as the force of gravity, they merely have a certain position in space; but it is often very convenient to consider them as having such a direction, and the above, we believe, has been generally adopted as their direction.

2. The important distinction between the terms "electromotive force" and "difference of potential at the poles," we regret to say, is not always made in English as it is in German and French. The former is the original or greatest difference of potential produced by the battery or machine, while the latter is the available potential at the poles, or the electromotive force diminished by the amount absorbed in overcoming the internal resistance, and, therefore, depends upon the current supplied or upon the external circuit. They are equal to each other when the circuit is open.

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and as each strip represents the end of one coil, there will be a coil short circuited by each brush every time the brush passes over the insulation between two strips. This can be shown by placing only one brush on the commutator of a machine whose magnets are excited by another dynamo; bright sparks will often be seen, especially when the brush is moved around to different parts of the commutator. When the brushes are too thick or when they lie tangential, they sometimes cover two of these insulations, there will then be two coils short circuited by each brush, and in many cases sparks and heating of armature may be expected. As this short circuiting cannot be avoided, it is necessary to bring those coils either in the neutral line or both halves on one side of the neutral line; in either case no current would then be produced in them, even if they are short circuited. If this is not done there may be bad sparking and heating of the armature (often attributed to the iron core), accompanied by the corresponding loss in efficiency. By taking many commutator strips and correspondingly few windings in each coil, there will be less potential produced in each coil and, therefore, less sparking and heating due to short circuiting.

Sparking at brushes is also probably due to the self-induction of the coils, and as this varies as the square of the number of windings, it is another reason for making the number of windings as small as possible and the number of commutator strips as great as possible. Other reasons which we cannot consider here lead to the same conclusions.

Suppose there were 16 commutator strips, then there are 16 coils or twice 8 in multiple arc. Every sixteenth of a revolution two coils are short circuited, so that there will be alternately 8 and 7 effective coils in multiple arc, thus varying the resistance and potential 32 times for each revolution. The internal resistance will vary $\frac{1}{8}$ or 12½ per cent., which may be sufficient to produce quite a variation of current. If there are an odd number of coils this will not be the case, as there will always be one coil and only one, short circuited by either one brush or the other, but never by both at one time, which is very much in favor of using an odd number of strips.

When the number of strips is small or an even number, the current must necessarily pulsate more. Such a current may be troublesome, as it may cause errors in calculation and measurement due to self induction. It increases the apparent resistance of magnet coils, and causes errors in most voltmeters in use, while the simple and convenient Ohm's law will not always be correct unless the troublesome factor of the counter-electromotive force due to self induction be subtracted from the reverse difference of potential. Whether the errors are appreciable or not depends upon the quantitative relations.

(*To be continued.*)

LIABILITIES OF TELEGRAPH COMPANIES AS AFFECTED BY PRINTED CONDITIONS.

BY J. P. KIRLIN.

The blanks upon which telegraph companies require persons to write their messages for transmission, have immediately above the address line, the following printed request: "Send the following message, subject to the terms printed on the back hereof (or subject to the above terms), which are hereby agreed to;" and on the back of the blank, or at the top, among the conditions referred to, differently worded by different companies but always of the same import, is found this one: "It is agreed between the sender of this message, and this company, that said company shall not be liable for mistakes or delays in the transmission or delivery, or for non-delivery, of any unrepeated message, whether happening by the negligence of its servants or otherwise, beyond the amount received for sending the same." The question now to be considered is, does a person who, without dissent, writes the message he wishes communicated, on such a blank, assent to this provision, and contract away his right to claim damages of the company, should the message fail to reach its destination, or arrive in a mutilated condition.

Now a telegraph company, either because it is bound to transmit intelligence for the public generally, or because the privilege of taking private property under the right of eminent domain is invoked in its favor, may be said to be in the exercise of a public calling; and is therefore under obligation to treat the public reasonably and fairly. It is liable to suit by a private individual if it refuses to transmit a proper message. It is also liable in case of refusal to transmit it for a fair price. Reasonableness and fairness, therefore, being the tests by which its dealings with the public are judged, the simple question to which the attention of the courts is addressed is this: Is the imposed condition reasonable and fair? We shall see that different courts answer the same question in different ways.

On one side it is claimed that as the sender of a message assents to the conditions, subject to which he asks the company to send the message, he should not afterwards be allowed to assert they are unreasonable or unfair. On the other it is contended that the condition is imposed, whether the sender wills or not; that he must assent to it, or appear to; that it is unreasonable, unfair, nullifies the contract, and is void. Which view is correct?

The argument of the telegraph companies is forcible and plausible. They contend that having printed the condition on their blanks, together with a notice calling the attention of the sender to it, and a notice that he is deemed to agree to the condition, subject to which he requests the company to send his message, he is subsequently estopped, in the absence of fraud, from denying that he assented to the condition, although in point of fact he did not read it. So far the reasoning is sound. One who writes his message on such a blank has abundant opportunity to read the matter printed on it; indeed he is asked to do so. He gives the company every reason to infer that he does assent and leads it, perhaps, in that supposition, to contract with him at a lower rate than otherwise. He should not, therefore, be permitted to avoid the incorporation of this condition in his contract, on the ground that he was ignorant of its import, otherwise he would profit by his own neglect. But it is further claimed that this condition forms a part of the consideration of the contract. The offer being to serve for a certain rate if the sender agrees to assume all risks, or at a higher rate if the company assumes a greater responsibility for damages. True, this arrangement ignores the fact that the condition is imposed upon the sender, and is not of his own seeking; that the agreement in case of a repeated message is to pay only fifty times the cost of sending, and not the real damages; and that the offer to insure the communication, is an offer to make a separate contract for which there is no consideration. Still in New York, Massachusetts, Pennsylvania, Michigan, Kentucky, North Carolina, and California, the highest courts have decided that a stipulation exempting the company from liability for any mistake or delay in the transmission or delivery of a message, or for not delivering the same, beyond the sum received for sending it, unless the sender orders the message to be repeated, and pays half the regular rate additional, is a reasonable and fair precaution to be taken by the company, and binding upon all who assent to it, so as to discharge the company from liability beyond the amount stipulated, for any cause, except wilful misconduct or gross negligence.

There is, on the contrary, a much more numerous class of decisions which hold that in so far as this condition attempts to exempt the company from the results of its own or its agents' negligence, it is void and of no effect. It is allowed in these cases that a telegraph company may, by special agreement or by reasonable rules and regulations, limit its liability to damages for mistakes and delays in the transmission of messages arising from atmospheric influ-

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ences and other kindred causes; but it cannot claim immunity from liability where the mistake or delay or non-delivery results from negligence. An exemption of that kind is here regarded as contrary to the policy of the law, having a tendency to discourage the exercise of that care and skill, which a due regard to the public interests requires of all who engage in a public calling.

The argument of the supporters of this view is that the sender, in contracting with the company, is not in a position to protect himself, and that the law therefore must protect him. The parties in making the agreement do not stand on an equal footing. The sending of any particular message is of little moment to the company; it may be of infinite importance to the sender. Oftentimes he cannot stop to argue, or sue the company for refusing to make its ordinary, as distinguished from its special contract. The business in hand must be attended to at once, if at all. All the companies impose the same terms. There is no choice between the different lines. He is accordingly obliged to accept the condition imposed. For the time being the employer is under a sort of moral duress and is compelled to submit to such terms as the company in its corporate greed, chooses to impose. The transaction thus becomes a cat and mouse contract, which the law refuses to sanction. The courts say that as not only single individuals, but everybody—in a word the public—is compelled to accede to these terms, the question becomes one of public importance; and the law as the protector of the public declares that the condition imposed in the manner indicated, is unfair and unreasonable; and in so far as it attempts to exonerate the company from the consequences of neglect, is absolutely void. This is the view which obtains in the courts of the United States, England, the Dominion of Canada, and in the States of Ohio, Maine, Illinois, Iowa, Colorado, Wisconsin, Georgia, Arkansas, Virginia, Missouri and South Carolina. In other states where the matter would probably be determined in the same way, no cases have yet reached the superior courts.

But even in those states which give the widest latitude to the companies in construing these conditions, no exemption is allowed unless the instance falls clearly within some stated exception. The ingenuity of the courts in finding a path for justice through and between the snares which technical skill has attempted to throw about the unwary, is both curious and instructive. For example, delay in the transmission has been held not to include delay before or after transmission. And the clause exonerating the company from liability "for mistakes or delays in the transmission or delivery, or for non-delivery of any unrepeated message beyond the amount received for sending the same" has been decided not to cover the case of a failure to place the message on the lines; an alteration before transmission; an alteration after transmission; an alteration after transcribing; or an alteration in transcribing at the place of destination. From which it appears that in the jurisdictions where most leniency is shown the telegraph companies, the most stringent rules of construction are nevertheless applied, and all rights which the sender has not most clearly bargained away are reserved to him and saved.

[It may be well to add that telegraph companies have in practice recognized the right of their customers to claim actual damages, by paying such demands in full, and deducting the amount from the salary of the employé who was supposed to be at fault even when his negligence could not be actually proven. This policy has been pursued for the pacification of "good customers," the transfer of whose business to rival companies would be a more serious loss than the payment of the claim, especially where the burden of expense could be readily placed upon the shoulders of a defenceless third party. This is the more unjust and indefensible when such errors on the part of a receiving operator are as a matter of fact unavoidable, being due to the imperfect operation of the modern "improved" apparatus, at the high rate of speed at which the work is required to be done.—EDITOR.]

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

COAL CONSUMPTION ON THE ELEVATED RAILWAYS.

[40.]—I see by a paragraph in the last ELECTRICIAN AND ELECTRICAL ENGINEER, referring to an account in the "Car Builder" for July, that some tests of the locomotives on the Third ave. elevated railroad were made by Mr. Angus Sinclair, to ascertain their actual horse-power and coal consumption. The indicator cards taken by him showed them to exert an average of 77.8 h. p., and to consume an average of 5.8 lbs. of coal an hour per h. p. I refer to it here because it is so satisfactory a verification of the results arrived at by a theoretical mechanical calculation, taking into account the stops, and agrees so closely with the results of such a calculation which I gave in the ELECTRICIAN AND ELECTRICAL ENGINEER for May, in which the power came out 75 h. p., and the average coal consumption 6.6 lbs. an hour per h. p. The results of 5.8 lbs. of coal, which is even less than I made it, is surprisingly low, and shows how little margin there is between the performance of these locomotives and that of stationary engines to make up for the losses that must necessarily occur in transmitting the power by electricity. If any one can take the elevated railroads and operate the trains by electricity generated by stationary steam engines, so as to obtain each h. p. on the track with less or materially less than 5.8 lbs. of coal per hour, I for one electrician would like to know how it can be done.

CHARLES G. CURTIS.

INTERESTING TELEPHONIC EXPERIMENT.

[41.]—In a communication recently published in the London *Electrical Review*, the writer describes a number of experiments in relation to microphonic transmission of sound. In circuit with a carbon microphone and telephone receiver he placed an automatic transmitter, in which he used a ribbon of paper having a line of small holes close together, running longitudinally through the centre, similar to that used in the Wheatstone instrument. The "automatic" was put in motion, allowing the current to pass through the microphone. The continuity of the circuit was continually broken, and words spoken directly to the carbon microphone without the intermedium of a diaphragm and without any substance whatever below the carbons were distinctly heard from the receiver, the articulation being as perfect as when the current was continuous. The writer has come to the conclusion that an undulatory current in a closed circuit is not necessary for telephonic transmission, and considers Bell's theory to the contrary thus experimentally disproved.

Having myself within the past two years, conducted a series of experiments in the same direction, I am prompted to make a few remarks upon this subject; and while I thoroughly agree with the aforementioned correspondent, my investigations have enabled me to go a step farther. Not long ago a scientific paper published an article on the theory of the carbon microphone, in which are quoted the opinions of some of our most prominent electricians and scientists.

All (with one or two exceptions) agree that variations of current passing through a carbon microphone are produced by pressure of the carbons against one another. Being a firm disbeliever in the variation of resistance theory, it is here that I differ. The statement that a certain theory is not necessarily true simply because it is backed up by a long list of scientific names, is one that cannot be ignored; and neither should "accepted" theories always be relied upon, even though seemingly substantiated with proof.

My theory of the action of a current in a battery transmitter is certainly a peculiar one. Briefly, it amounts to this: that the invisible electric current is *itself directly influenced* by the impacts of air affected by the voice, and that the microphonic contacts have *nothing whatever* to do with the transmission of speech in the sense of producing electrical undulations by variation of resistance in the circuit.

In order to substantiate this theory, one of my first experiments consisted in affecting the current in a sufficient degree to deflect the needle of an ordinary detector galvanometer by pro-

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ducing sound upon a microphone (?) transmitter, the carbon "contacts," instead of being in direct electrical connection with each other, were, *fully one-eighth of an inch apart.* This may appear incredible but it is nevertheless true. Not only have I succeeded in producing a telephonic receiver without the use of either magnets, diaphragms, wire, or resonating cases of any sort, but also in transmitting articulate speech to considerable distances with a break in the conducting wire. At the conclusion of my investigations I hope to present to your readers a full account of these experiments in detail, and elucidate my theory in regard to the electrical transmission of sound. WM. A. J. KOHRN.

No. 1 Franklin St., San Francisco, Cal.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Electric Lighting in New York City.—The Stock Exchange takes Charge of Reporting Quotations.—Enterprise of the Commercial Cable Co.—The Badly Ventilated Western Union Operating Room.—Electric Lighting and Pole Permits in New Jersey.—A New North River Cable.—Unpleasantness among the Wire Manufacturers.—The "Special Delivery" Postal Innovation.—Edison's Gift to Cornell University.

THE average traveler must now deem New York city pretty thoroughly lighted with electricity. Along the river fronts, up Broadway, through the principal avenues, along the streets leading to the ferries, and in the city parks, over the East river bridge, together with a large number of private lights, notably on the Bowery, it will be readily seen that those portions of the city which come under the eye of the casual visitor are thoroughly illuminated. Should it eventually prove true that the existing companies will abandon arc lighting rather than place their wires underground, it is pretty certain that the public will not be ready to return to the old system of street lighting. The business is now amicably divided between the Brush and United States companies at the contract price of seventy cents a night, which is probably satisfactory at the present cost of carbons. Incandescent lighting is also becoming quite common in the city, especially in new apartment and office buildings. It would doubtless be still more prevalent but for the practice of duplicating it with a gas system to be used in the case of an emergency. There appears to be no good reason for this, for although electricity may occasionally fail, more care would be exercised in giving it proper attention, if it was not understood that gas could be at once utilized in its place.

The Edison Electric Illuminating Company has just declared a quarterly dividend of one per cent., the profit being derived from the operation of its central station on Pearl street.

A radical change in reporting stock sales was made on the 1st of October. Since the beginning of this important branch of the telegraph business in 1868, this work has been done by Morse operators, employed by the different companies, which received the privileges of the floor of the Stock Exchange. When competing companies were in the field, each had its own corps of reporters, working independently of the others. There were at one time three, and since the advent of the Commercial Telegram Company, there have been two sets of reporters. This work has now been undertaken by the Stock Exchange, and is in charge of R. J. Hutchinson, who has been identified with stock reporting since the days of the Manhattan Quotation Company, in 1872. Six operators were dispensed with under the new arrangement, which places the two companies on an equal footing in getting quotations, with the result that in an active market, the Commercial tickers are far ahead of the Gold and Stock. This should have the effect of hastening the introduction of the Scott printers, which it is expected will turn the tables. Until this is done, the old company can hardly expect to wipe out its young rival, for stock quotations, like buckwheat cakes, are preferred hot from the griddle.

The Commercial Cable Company is another thorn in the side of the would-be monopolists. It is perhaps the only concern of the kind which has ever advertised in the *Herald.* It is also appealing by various striking methods, to the eyes of the passer-by on Wall street. Upon an ornamental cast-iron post at the corner of Broad, a gilded globe, apparently four feet in diameter, and appropriately lettered, has been erected as a clock, which is now externally illuminated at night by an arc lamp a short distance away, but in the dim future it is expected that three incandescent lamps at its base will perform this duty. In order to relieve all suspicion of British influence, which is associated with submarine cables, the globe is surmounted by a gilded eagle gazing on the statue of George Washington in front of the Sub-treasury. One of the Commercial cables, which was broken, has recently been repaired, and both are now in operation.

In my July correspondence, writing of the field which existed in this city for the introduction of electric motors, allusion was made to the use of a Sprague motor in driving a fan for ventilation of the Western Union operating room. The experiment was successful, and the improved condition of the air was highly appreciated by the operating force. The fan has been removed, doubtless for financial reasons. Either this or a similar device should be put in use at once, as the vitiated condition of the atmosphere in the room has been a growing evil since the occupation of the building, as the force in the office has increased. The gallery occupied by the commercial news department is perhaps worse than any other part of the room; but every portion is bad enough. This state of affairs should not be permitted to exist a single week. So long as it was an unsolved problem there might have been an excuse for refraining from the expense, but such is not now the case.

Electric lighting is gradually pushing its way into the conservative state of New Jersey. An Edison isolated plant of 250 lamps has been placed in the exposition of the Phil. Kearney Guard, Co. C., at Elizabeth, and another of 600 lamps in the Temple Rink. Pope, Sewall & Co. have also secured a sufficient number of arc lamp subscribers to warrant them in constructing a Schuyler plant, which will be in operation before the days begin to lengthen. A company has also obtained permission to exhibit its system of street lighting at North Plainfield, with a view to its final adoption by the authorities.

The American Telephone and Telegraph Company has applied for permission to erect a line of 45-foot poles in Bayonne, from the Kill von Kull to the Morris Canal.

The Metropolitan Telephone and Telegraph Company has just laid a new seven-conductor kerite cable across the North river, from the foot of Cortlandt street, New York, to York street, Jersey City. As the shore end of a former cable was destroyed by the fire on the Red Star wharf, the new cable terminates at the cable-house, instead of being strung along the pier as before.

A war of words is being carried on between the rival manufacturers of what is known as "underwriters" wire for electric light construction. The proclamation of one party gives rise to a counter effort of the other, the object being to frighten purchasers by the old-fashioned country threat of "taking the law of them." The manufacturers on both sides are, however, ready to guarantee purchasers of their wares against loss, so the users of wire may pursue the even tenor of their way.

The advent of the new special delivery "h. l. h." postage stamp was marked by no greater excitement than a tinge of curiosity to see what it looked like and how it worked in practice. The blundering old lady was on hand as usual to request the clerk to tell the carrier who delivered her letter to accompany it with a certain verbal message which she had forgotten to put in her missive before posting it. The man who puts on the h. l. h. stamp without the ordinary G. W. accompaniment, and expects his letter to be delivered p. d. q., has also discovered that the system is a delusion and a snare. With district messengers for a reasonable distance at 10 and 15 cents for local purposes, and a telegraph service at about the same figure, to points 250 miles away, either by day or night, the field for the latest postal experiment is not altogether a promising one. It has a mission, however, as it may lead to the possibility of insuring the delivery of letters the same day mailed in the morning to such cities and towns as are within three hours of New York by rail. This applies, however, to lengthy communications or papers of value, and in many cases it will compete with express as well as telegraph companies. Ten-word communications will still go by wire. The postal service has been gradually improving for years; but its chief excellence, like that of the telegraph, is far more appreciable for long distances than for local use. An institution which carries THE ELECTRICIAN AND ELECTRICAL ENGINEER, for instance, 3,000 miles to San Francisco and delivers it by carrier for half a cent, while charging two cents for delivery in the city of its publication, is certainly open to the charge of inconsistency.

Thomas A. Edison has notified Professor Robert Thurston, the director of the Sibley College of Mechanic Arts of Cornell University, that he proposes to present the school a complete electric-lighting plant for the new workshops and the mechanical laboratory. The university has accepted the gift.

NEW YORK, October 23, 1885.

CHICAGO.

Gleanings from the Berlin Conference.—Telegraphing in Theory and in Fact.—The City Fathers Propose to Investigate Underground Permits.—The Schuyler Company Preparing to Start Up on State Street.—Estimates Wanted for Lighting the River.—Arc Light Competition in Milwaukee.—Proposed Extension of Electric Lighting in Chicago.—Improvements in the Hanging of Lamps.

ON the occasion of the late international telegraph conference at Berlin, in honor of the event a special meeting of the electrotechnic society was held.

The president in a speech of welcome said, that "for telegraphy there is neither time nor space," and spoke of the pleasure, even to the habitual receiver of despatches, "when the telegraph brought news from the uttermost regions of the globe; or, when

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these told of astronomical discoveries brought from beyond the seas within the space of a second, and finally, when we consider it within the range of possibility that in the future, thanks to electricity, we may be able to recognize the voice of friends separated by vast expanses of territory. This," he continued, "is the ultimatum of which this conference is the forerunner."

He congratulated himself and his hearers that Germany was the cradle of the electric telegraph. This fact, which marks a red-letter page in the history of the nation, should be to Germany a powerful incentive to develop by all possible means the activity of the savants of an institution representing the nations of the civilized world. Among the numerous problems which the study of electricity and electro-technics presents, is the great question of electrical phenomena in their bearing upon telegraphy.

The following resolution, introduced in the conference by M. Curchod, chief of the international telegraph bureau of Berne, adopted at the seance of August 13, explains itself:

"The international bureau of Berne is authorized, when occasion arises, to publish such statistics of atmospheric electricity, storms, lightning rods and terrestrial currents, as may be required by deliberations of the international conference, for the determination of electrical units."

The resolution renders the establishment of a centre of information for the prosecution of important researches possible, something which has heretofore been sadly wanting; while discoveries and theories in this line will hereafter not only be given to the world of science in a tangible form, but such data will be collated and recorded where it will be ever available to the world of progressive science.

There is something in the welcome alluded to above, however, which appeals to a sense of the ludicrous in the mind of the average operator. It will be yet a long time before the learned professor will be enabled to recognize the voices of loved ones at such distances as are here theoretically given. At the present writing such recognition is no dead sure thing two blocks round the corner; and from the jolly way in which the speaker makes dots and dashes fly round the earth it is highly probable that his experience at an humble railroad station, where the operator was also switchman, waiting for an answer to a rush message, has been quite limited—and there have been instances nearer home where messages have taken as much time as the summer sun to cross one half of Paris, which when delivered might be astronomical or religious, Hebrew or Choctaw, as far as the ordinary citizen could ascertain. This girdling-the-earth-in-forty-minutes business is all very pretty in poetry, but it don't average up well at tariff rates of so much a word.

Our city fathers are about to investigate the matter of permits as between the underground companies and the electric light people. In the session of the 12th the following preambles and resolution of inquiry were adopted:

"*Whereas* on July 31, 1882, page 97, Council Proceedings, an ordinance was passed granting to Henry Corwith and others, their successors or assigns the privilege of constructing and operating an undergr und conduit for electric wires in the streets and alleys, which said franchise is now held by a corporation known as the Chicago Sectional Underground Conduit Company, that section 5 of said ordinance provides that other persons shall be allowed to use said conduits, after being duly authorized by ordinance; and,

"*Whereas*. It is reported that said conduit company has allowed parties to use said conduits without such parties having first obtained the consent of this Council by a proper ordinance, while it has excluded others who are desirous of securing its benefits and willing to pay for the same; that said conduit company has granted to persons the right to dig up the streets for the purpose of laying electric wires on permits issued to said company for its own use by the department of public works, all of which are in direct violation of the spirit and letter of said ordinance; and,

"*Whereas*, Said conduit company has failed to appreciate the fact that a most valuable franchise was granted to it by the city, in that it compelled the city to pay a bonus of $10,000 for the privilege of providing for its wires: It is therefore

"*Ordered*, That the law department be and is hereby directed to cause an enquiry to be made as to the above facts bearing upon the violations of said ordinance, and to take such action toward the forfeiture of said franchise as the value of the evidence will warrant, with the view of obtaining for the city the privilege of using said conduits without cost, and to secure the money paid by the city for such privilege, and report to this council what action it has taken in the premises."

The Schuyler Electric Light Company, which is endeavoring to open up a plant on either side of State, between Madison and Monroe, requires a permit to cross State. At the same meeting an ordinance to this end was offered, and after some slight skirmishing, referred to the Fire and Water Committee. At the same meeting the city electrician was directed to furnish estimates for lighting the main river, and the north and south branches, from Kinzie to Harrison street.

Two competing companies from here—the Sperry and the Badger—are pestering the Milwaukee people for a chance to introduce arc lights in that city.

On the same evening that our municipal fathers were working on electric lighting here, the solons of our sister city were also wrestling with similar matters. At the meeting two weeks previous, an ordinance was passed by a vote of 25 to 14, permitting the Badger people to erect and maintain plants, and run wires overhead in certain localities, while it required the company to place its conductors under ground in other portions of the city. But the bridge which had brought the company safely over the chasm thus far had still one uncertain plank, and this failed when the procession reached the spot. The ordinance was vetoed and—curious coincidence—the vote on the proposition to carry the ordinance over the head of his honor stood as on the previous vote, 25 to 14, although there had been some changes among the members. One more in its favor would have made the necessary two-third vote. Then came an ordinance in favor of the Sperry company, which now takes its chances, while an amended Badger ordinance is also listed for the race, and the pro and con petitions and remonstrances from the good people of Milwaukee are strewn as thick as leaves in Valambrosia, or, perhaps as more appropriate in this wooden country, as slivers in a lumber yard.

There was sharp word shooting in the debates on this august occasion, and the probability is that at the next regular convocation of the council there will be like Smith's razor strops, "a few more left of the same sort."

Electric lighting is to be rapidly extended over the north and west divisions of Chicago. Arrangements have been completed by which central plants will be extended over those districts at once, and the Dorsett conduits will be availed of by a new organization which promises to do thorough and complete work over large areas of territory. Enough experimenting has been done to convince those who desire to install this species of work that the best is the cheapest in the long run, and that while the original outlay to ensure the most satisfactory results dips deeper into the pocket, the subsequent account for maintenance is much less, and really more economical.

Heretofore there has been much annoyance arising from the unseemly and awkward system of hanging outside lamps. A plan recently submitted, which has so far no objectionable features, is to be put into service at once, as an experiment, and if this works as well as it is believed it will by those who have seen it in sketches it will do away with the objectionable clothes-line loops, relieve the halyards of the strain to which they are now subjected, and at the same time permit of the raising and lowering of the lamp, bringing it in the latter case to a portion of the walk out of the path of pedestrians. We shall see.

CHICAGO, Oct. 17, 1885.

PHILADELPHIA.

The Western Union and Bell Telephone Companies Decide to put Some Wires Underground.—President Bentley says Subterranean Service will be Limited.—New Quarters of the City Electrical Department.—Detrimental Effects of Abandoned Aerial Wires.—Litigation Regarding the City Pole Tax.—The "Novelties" Exhibition.

AN ordinance was passed at the last meeting of councils authorizing the Western Union and Local Telegraph and Bell Telephone companies to put some of their wires underground. President Bentley said recently that the move might be regarded as a step on the part of those corporations towards eventual compliance with the ordinance directing that all the city wires be run through subterranean conduits. There would not be time between this date and the 1st of January, 1886, to put all the wires underground, but the completion of the plan now contemplated would give ample opportunity for ascertaining definitely whether subterranean telegraphy could be made a commercial success, as it was designed to have the work finished in time to allow of a thorough test of the working of the wires during the coming winter. The period, however, when all overhead wires would disappear he considered quite remote. It was only in the heart of the city and within a circumference including comparatively not a great many blocks that the trouble with the overhead wires manifested itself. For distant sections, and further out still, in the suburbs, the wires were so scattered that no inconvenience was experienced from having them overhead, and in such localities they were an absolute necessity.

No company, indeed, would consent to extend a conduit system beyond very restricted limits, as the outlay would be ten times greater than the income, and suburban residents, instead of being able to have telephones connecting their homes with their places of business in the city, would simply be informed by the telegraph people that they must decline to incur the extra expense. That the people themselves might choose to combine and put down conduits leading to their homes, president Bentley did not appear to contemplate; no doubt, on account of the expense attending that display of enterprise, and, therefore, he believed in the practical perpetuity almost of the overhead wires in more remote neighborhoods, as the telephone had become so important an accessory of American every day life, being used in this country to an extent absolutely unknown in Europe, and by people who, on the other side of the water, would consider electric communication a luxury far beyond anything their means would permit them to aspire to. French and even English electricians, he remarked, on coming to this country expressed themselves as highly astonished at finding the telephone as almost an article of domestic comfort and convenience, and assured him that with them it was so used only by the nobles or by wealthy manufacturers, and was still far enough away from being in anything like common use among the well-to-do classes at large.

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Early in January next, chief David R. Walker, of the city electrical department, will begin to move into his new quarters in the public buildings. It will take at least a year for him to get settled, and he will have the finest electrical system in the world under his control. The wires used by the department all enter the buildings at the northeast and southeast corners, through two great tunnels, which extend to the curb, and will then be carried to the northeast tower. The operating, receiving and transmitting rooms and the office of the chief are on the fifth floor, the storage room is on the sixth floor and the battery room on the seventh. The wires will be carried up through a box in one angle of the tower to the rooms above mentioned, and the box will be large enough to contain a ladder, provided with convenient platforms, by means of which the wires can be examined and repaired at any time. The main operating room is 46x51 feet and it is connected with the office of the chief. At one end is a sleeping room, which will be used by linemen and operators who go on duty at midnight.

"When my new quarters are completed I shall feel very proud of them," said chief Walker. "I have adopted every practical idea that I could get hold of in their fitting up, and I think the electrical department of Philadelphia will soon be as well equipped and as comfortably and conveniently quartered as that of any city in the world."

The new system was thoroughly inspected yesterday by the chief, in company with William B. Gill, superintendent of the Western Union company in Philadelphia; D. Doren, general superintendent of construction for the Western Union, and a party of newspaper men.

Every time a storm, such as that which prevailed in this city a few days ago, occurs, telegraphic and telephonic communication between different points in the city is greatly interrupted, and business men experience great inconvenience in transmitting despatches. "A great deal of this trouble," explained chief Walker of the electrical department, "is due to old, abandoned wires breaking down during the storms and falling on the others. Several years ago various telegraph and telephone companies strung their wires all over the city on housetops or anything else that they could fasten them to. Many of them were put up purely for speculation, and they are of poor quality and badly strung. Other companies lost their franchises in the courts and were compelled to abandon the use of their wires. The disused wires have become rotten and every time there is a storm many break and cross the working wires, causing great confusion. The trouble will continue until they are removed.

There has been a consultation between counsel for the various telegraphic companies in this city, relative to the order recently issued by Judge Hare for a re-hearing of the case of the City *vs.* the Western Union, Mutual Union and Bell Telephone companies, which was an action to recover license money for privileges. The referee in the case originally decided that the city's charges were unreasonable, and his report was confirmed by Common Pleas Court, No. 2, June term, 1883. By this decision the city would lose about $15,000 per annum. The superintendent of the electrical department, however, has since appealed to the Supreme Court, and the case will be heard again. The United States court, sitting at New Orleans, recently decided in a similar suit that the city could charge $5 per pole if it liked, whereas the charge in Philadelphia is only $1 per pole.

Although the Novelties Exhibition is doing quite well as far as the daily and nightly attendance is concerned, I fancy the average will not come up to that of the electrical exhibition held last year. Outside of dynamos and electric lights, there is little to be seen at the "Novelties" in the "electric" line, still it is a very interesting place for one to go.

The board of judges who will award the premiums and diplomas has been organized and is ready to begin work. The exhibits have been arranged into 21 classes. The first premium is a silver medal with a diploma, the second, a bronze medal with a diploma, and the third a certificate of honorable mention. There will also be awarded a medal of honor to the invention which shall be decided to contribute most largely to the welfare of mankind. It is hoped that the reports of the judges will all be presented before October 20th.

PHILADELPHIA, October 19, 1885.

SAN FRANCISCO.

Improvement in the Telegraph Service.—A Subterranean Cable to be Run Along the Snow Sheds.—The Electrical Exhibits at Mechanics' Fair.—Electric Light Rivalry.—The Supervisors Object to Additional Poles in the Streets.—Extra Operators Employed by the Western Union.

THE visit of Col. Clowry and his able lieutenants, C. H. Summers and M. C. Bristol, to the Pacific coast has been prolific of the most beneficial results, indeed a trip every six months would work untold wonders in expediting business. The southern lines which previously were of no benefit to San Francisco as an outlet for business now work beautifully, and indeed it is a pity we have not such a wire to Ogden. Mr. Summers will stand no fooling, he knows the capacity of a wire and expects it worked accordingly, and to insure this has reports of the day's business sent to him every morning to Chicago, hence if the middle route is "gone" we are not completely isolated as was the case many a time previously.

We are to have a seven conductor double armored cable laid between here and Oakland, and also a cable to be laid underground the entire length of the snow sheds across the Sierra Nevada summit on the Central Pacific. These are both wise moves, and it is to be hoped the Oakland cable will be laid from a point out of the way of dragging anchors, which invariably bring trouble when we are treated to a strong south-east wind, once or twice a year. A snow slide carries all before it over the mountains where the snow sheds are built, and a cable there will insure us telegraphic communication, when all else fails. Bristol's quick eye saw this and supported supt. Jaynes in his request for the cable which was allowed. Col. Clowry, Mrs. Clowry, Miss Estabrook, Messrs. Summers and Bristol occupied the Western Union car "Puck," and the ladies particularly were enchanted with California. The Mechanics' Fair has just closed. The electrical exhibit was the same as heretofore, but the various wares were tastefully displayed. The California Electric Co. was outdone by the Pacific Electrical Supply Co. in neatness and variety of electrical machinery and apparatus. Mr. Osborne exhibited the Stockwell sewing machine appliances and motor which attracted much attention.

The Thomson-Houston Electric Light Co. is waging a bitter warfare against the California Electric Light Co. (Brush) to obtain from the supervisors equal rights to erect poles in the streets or be allowed to string wires on the poles of the California company. The board is averse to permitting any more poles in the streets, and as P. B. Cornwall is the head and front of the California company, and being a very prominent politician, the chances are, the Thomson-Houston people will be "left."

The Western Union operators (with one exception) in this city resolved to refuse to do extra work without extra pay, and so notified the superintendent, who advised them to take no hasty steps, but to submit to him a statement of the case and he would present it to Col. Clowry, all of which has been done, and it has resulted, not in allowing extra wages, but in increasing the force two operators. Judging from appearances, I should say that while the operators are pleased with the prospect of lighter duties, they would prefer the "extra," as some have families, and could thereby earn a little more every month.

Mr. Leonard W. Storror has resigned the position of cashier, and his place has been filled by George Senf, of Virginia City, Nevada.

SAN FRANCISCO, Cal., Sept. 27, 1885.

BOSTON.

The Tribulations of New England Telephone Subscribers.—The Telephone as a Political Issue.—Increasing Use of the Judkins Train Signal.—The Serson-Welsh Battery.—A Peculiar Dynamo Accident.—The New England Meteorological Society.

THE New England Telephone Company quietly pursues its settled policy of raising the rentals throughout its territory. There is still fluttering and protesting on the part of the subscribers, but the wheels turn around just the same; many telephones have been taken out and many more put in, so the general average will be kept up. In one town all of the doctors agreed to allow their telephones to be taken out, and they were. Soon all of the doctors but one found out that the *one* had his telephone in good working order, and was scooping in all the sore throats and baby troubles in the neighborhood, so the rest, as a matter of protection, had to succumb and continue their acquaintance with the "hello" girl at the central office.

The thing works about like the above incident. If the rates were oppressive it would be quite a different matter. The general public look at their telephonic apparatus and think the whole outfit, line included, does not cost as much as they pay for their service in one year, and conclude that the telephone company must be making an immense amount of money; quite forgetting the cost of maintenance, the liabilities incident to the business, etc. This kind of an argument would not suit, say the doctors mentioned, if a patient should complain of his bill for services, and conclude, as the prescription did not cost but half a dollar, the doctor must be making money to charge $2.50 or $3 for a visit. I had a conversation with a telephone subscriber recently, who was grumbling because his telephone services cost his office $120 a year, with the privilege of talking with 5,000 people, and with many more at a slight advance, and asked him how much he used to pay for an errand boy. He said $3 per week, or $150 per year. And yet was a "kicker" because he got more service for less money.

According to present indications, the local telephone matters will furnish plenty of excitement for our next legislature. The parties are now nominating candidates for the new legislature, and the "New England Telephone League," by its represent-

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atives, appear at the nominating conventions and submit a circular and resolution, as follows:

BOSTON, MASS., Oct. 3, 1885.

DEAR SIR:—We very much desire that in every senatorial and representative convention a resolution similar to that following this note may be passed. In several legislatures laws limiting the charge for telephones to $3 per month have been passed and are in force. All over our state, except in the Cape district, telephone rates have been, or are to be, raised, and the entire commonwealth is in a turmoil over the uncalled for advance. The American Bell Telephone Company, having only $550,000 actually invested in telephones, is paying out in dividends over $3,000,000 annually. The spectacle of the business and professional men of the state paying a tribute of 750 per cent. (this is the exact rate) is an humiliating one. Respectfully,

NEW ENGLAND TELEPHONE LEAGUE,
P. O. Box 2567, Boston, Mass.

Resolved, That this convention is opposed to the present telephone charges imposed on the people by the telephone monopoly, and urges the General Court, at an early day, to fix by la w the rates which telephone companies shall be allowed to charge within this state.

They evidently mean business, and propose to have an anti-Bell telephone "general court" if they can.

The Judkins Electric Signaling Company are pushing their apparatus, a substitute for the bell cord on railway trains, very extensively. They have just contracted with the Boston and Maine Railroad Company to equip all of their passenger cars and engines. The railroad has in use over 200 engines and about 500 cars. The Judkins signal is highly recommended by all the railroad officials using it.

The Serson-Walsh reservoir battery has been put on the market, with substantial claims for merit. It is an open circuit battery, but the inventors say it will work on a closed circuit longer than any in use. At the Boston and Albany railroad depot, on the gong circuit, two cells did the work of 10 Leclanché cells. The inventors further say it will last 12 to 18 months without renewal or attention, keeping itself clean, and is self-feeding. It is tightly sealed, and made for train signals, bells, etc.

At the Grinnell cotton mill at New Bedford, on the 24th ult., an accident occurred while electric lights were being put in, graphically described as follows by the newspaper scientists:

"While workmen were putting in electric lights, under the management of F. B. Comings, of Dorchester, steam was turned into the dynamos, when the pipe burst, throwing Comings, together with superintendent Kent, of the mill, and the engineer, across the room and into a pit. The two latter escaped with slight injuries, but Comings was badly cut and scalded about the face, head and breast, perhaps fatally. He was taken to St. Luke's Hospital."

In view of such accidents, it is full time that dynamos were put underground.

The second annual meeting of the New England Meteorological Society, was held in Boston on the 20th. The following officers were elected—president, W. H. Niles; secretaries, W. H. Davis, D. Fitzgerald; treasurer, E. B. Weston; director, W. Upton. A report of the first year's progress and work was read by Mr. Winslow. Among other achievements the society has succeeded in introducing the signal flag service in over 100 towns in New England. Mr. W. M. Davis read a paper on "Thunder Storms in New England in the summer of 1885." Over 450 observations had been sent in from society observers who are well distributed over New England. The speaker then described the nature of a thunder storm and the atmospheric influences which preceded it.

BOSTON, Oct. 20th, 1885.

ELECTRICAL NEWS AND NOTES.

THE ELECTRICAL SUBWAY COMMISSION.

The resumption of the sittings of the Commission on September 29th, after a recess of two weeks, was marked by a larger attendance than usual. An application from the president of the Metropolitan Telephone and Telegraph Company was read, for permission to construct a conduit for its wires from the corner of Wall and Water streets in this city to 180 South street, near the East river bridge. The construction of the conduit is to be of a similar pattern to that already put down by the same company in 39th street, which is a box made of creosoted wood through which cables are drawn. From Wall street to Fulton it will contain 150 wires, and from Fulton northward to 180 South, 300 wires. This subterranean structure is intended to supersede two lines of poles carrying 185 conductors, and as they are now overloaded, the company is anxious to complete the work before winter sets in.

Action upon this proposal was postponed until the next meeting.

A letter was read from the board of fire commissioners, stating that no permission had been granted to electric lighting companies to place their wires upon the poles of the fire department, but that in some instances attachments had been made at crossings, in order to avoid any liability to contact by the sagging of wires.

Daniel Moore submitted the plans of Captain William Mackintosh, the inventor and patentee of a system to which he had devoted much thought, and it was the outcome of many years of practical experience. Under his patents of January 20, 1874, he claimed the exclusive right for laying down sectional cables, terminating in alternate working chambers. Such chambers or manholes are to be connected by iron or earthenware pipes in lengths of from 12 to 25 feet, these pipes being imbedded in plastic material. The estimated cost of a system of this character was less than $10,000 per mile. It permitted the drawing in and out of such cables as might be adopted by the various electrical companies. It had been submitted to different corporations, who made no objections to any of its features, and some of them had entered into negotiations for its use. The advantages claimed were:

1. That the water, sewer, gas and steam systems present no insurmountable obstacles to its adoption.
2. Ready access to the wires placed in it.
3. The cost, if not less, is no greater than that of any practical system.
4. Its durability is unquestioned, and the system is of an expansive character readily accommodating itself to the future growth of electrical service.

Mr. Moore stated that it was not in practical operation.

Mr. Shelbourne disputed the broad claim made in behalf of the Mackintosh patents, that they covered all systems embracing working chambers connected by pipes, such features having been used in Europe for 30 years. The patent was what is known as a combination patent, the only novel feature being the so-called comb which it was proposed to use in connection with the conduit.

Mr. Moore replied that the owners of the patent were fully prepared to defend their rights.

David Brooks, of Philadelphia, in presenting his system, stated that in the event of its adoption he was authorized by president Norvin Green of the Western Union Telegraph Company, to say that a construction company would be immediately formed, and the work pushed forward in the shortest possible time. There were four miles of his system laid in Europe, a short piece having been put down in Belgium in 1879. That had been subjected to the severest tests, and its insulating qualities had not deteriorated. All work done abroad had been guaranteed. There was no system in Europe which permitted single wires to be drawn out and replaced. It had been shown by experience that in doing so, other separate wires were damaged, and therefore it had proved to be more satisfactory to draw in or out an entire set of wires at one time. For telephone work, 400 wires had been placed in a single pipe in New York city. On Mercer street there was a splice box every 45 feet. In Philadelphia 2,000 feet had been put down in a single day along Front street, the trench being dug, pipe put down, and street repaved. It was the cheapest of all systems. [A fully illustrated description of the Brooks system appeared in the ELECTRICIAN AND ELECTRICIAL ENGINEER, November, 1884.—EDITOR.]

Mr. Jaegel presented a new model of his street railway conduit, in which a cast-iron subway formed the foundation for each rail of the track.

On Thursday, October 1st, Sidney F. Shelbourne stated that three years had elapsed since the incorporation of the New York Electric Lines Company, which, as indicated by its name, was not for any special branch of electrical service, but to furnish lines for the use of all systems. During this period his entire time had been devoted to this subject. His company had not only a system, but patents covering that system. In April, 1883, the company obtained a franchise for putting it down in the streets of New York, by the terms of which two per cent. of the gross receipts were to be turned over to the city. The companies made the plea that they could not continue their business if compelled to put their wires underground, because they would not work. He presented a sample of the cable which his company proposed to use, which, he said, was the only cable in the world which would nullify dynamic induction. The Metropolitan company ordered 6,000 feet of this cable to put up overhead, and last spring it was connected with the Spring street exchange. So far as tested it had proved satisfactory.

A conduit is simply a hole through the ground. When the pipe is made of an insulating material, induction cannot be prevented. He had come to this conclusion, that the best, the simplest, the most durable and the most reliable article for this work was cast-iron pipe. The pipe, according to his plan, was not made round, as a tube of this shape would not permit a sufficient number of cables to be drawn through to economically utilize the space. It was nearly oval in shape, with straight perpendicular sides, and rounded at the top and bottom. In this the cables could be more readily drawn parallel to each other, the first layer of three filling it up to the beginning of the straight sides, which confined the subsequent layers to their proper amount of space, instead of permitting them to run from side to side as was the case in a round pipe where the increased width gave annoyance in that way. In every second street would be placed a manhole, which was a cast-iron box with a sealed cover, and gas-tight. His company owned what he called a cable carrier, by which cables could be readily placed in a conduit without the

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slightest injury to them from abrasion. Old cables could also be readily underrun and removed by the same means. For the distribution of wires he had devised an ornamental cast-iron post, one of which being located at each block, the wires were led up through it by a small lead-covered cable to the adjacent roof and thence to the rear of the buildings as required, or if preferred they could be carried underground through the cellar walls.

Mr. Shelbourne continued his remarks at the session of October 2d, when he presented a different pattern of conduit in which an iron pipe about eight inches in diameter was filled with two inch tubes imbedded in cement, the tubes being first dipped in coal tar, and were to be in three feet lengths. Such a pipe with 20 tubes would cost from 75 to 80 cents per foot. The largest lead covered cables made by any process excepting his were from ¾ to ⅞ of an inch in diameter. Cables were usually either of kerite or gutta-percha wires wrapped and drawn through the conduit. The Western Union company had undertaken to draw through plain gutta-percha cables in their Broadway pipe, and had gone as far as Grand street, but they had stopped on account of the steam heat melting the gutta-percha insulation. The vice-president had informed him that as soon as he could furnish a cable it would be adopted. Mr. Shelbourne closed his presentation with an explanation of his very ingenious plan of numbering and connecting wires in the manholes.

On October 7th a plan devised by George M. Cushing, of Boston, was presented by his attorney, which was a conduit to be constructed of vitrified earthenware in the form of a trough, to be placed under the gutters with covers at suitable locations, the joints to be strengthened by brick abutments, and the whole covered with bluestone flagging. Connections with the sewers are to be made at the lowest points to facilitate drainage. The estimated cost of a conduit of this pattern, 4x3½ feet, was $3.30 per running foot. No provision was made for the separation of the different services.

On October 8th E. H. Austin exhibited samples of the conduit proposed by William Redde, which was patented in 1873, and put down for exhibition purposes at the Centennial Exposition at Philadelphia. It consists of small glass tubes imbedded in an insulating composition or plaster-of-paris within a wrought iron pipe. These tubes are intended for the accommodation of bare copper wires, and may be furnished in lengths of 10 to 15 feet. Mr. Austin stated that at the time the Gold and Stock Telegraph Company moved its operating room from 61 to 197 Broadway, he offered to make a very liberal arrangement and guarantee the working of the wires underground if the company would adopt this system, in order to give it a thorough practical test. The company, however, did not wish to demonstrate the feasibility of subterranean work, and consequently his proposition was rejected.

October 9th the Hastings Pavement Company announced that in case a conduit of masonry was adopted, the blocks composed of asphaltum and limestone, moulded under heavy pressure by that company, was a desirable material for the purpose.

Mr. Anderson, in behalf of the Metropolitan Telephone and Telegraph Company, said that in a letter dated September 24th, that company applied for permission to construct a conduit, and it was desirous to place its wires underground. The pole lines were overloaded, and in order to insure the effectiveness of the service they must either be rebuilt or the wires placed underground temporarily if not permanently. The company desired to retain such poles only as were necessary for the distribution of wires to subscribers. As Mr. Anderson was unable to state just how many poles would be required for that purpose he was requested to notify the Commission in writing exactly what was proposed, when the matter would be taken into consideration.

October 12th T. A. B. Putnam, of the Railway Cab Signal Co., 40 Broadway, presented the plans and specification of his cast-iron conduit, which is to be in the form of a bisected pyramid, divided into compartments by iron partitions running longitudinally through the structure. In the sketch as shown there were four of these, making five spaces in all. A conduit of this pattern, 24 inches in width at the base, 12 inches at the top and 24 inches high, would accommodate 5,000 wires. The top compartment would contain light and power wires, the next below it fire alarm and district, the next telegraph and quotation, while the lower two would be devoted to the telephone service. Each class of wires being surrounded by a metallic wall abutting on the earth at each side, the inventor claims that they would be entirely free from interference excepting that arising from wires of their own class. The conduit would be provided with manholes, and a distribution pole made with five longitudinal compartments would be placed every 500 feet. The cost of a conduit of this character, accommodating 5,000 wires, would be about $44,000 per mile. Its advantages are claimed to be, freedom from induction, facility for handling wires, and the low cost per mile of wire.

Geo. B. Pennock offered what he believed to be the cheapest practical system, by which he would undertake to put down all the wires in the city for $500,000.

Marcus Marx submitted a sample of pipe for underground work made of 1¼ turns of sheet iron, upon the inside and outside of which was a heavy layer of asphaltum. It could be supplied at half the cost of iron pipe.

On October 13th the Standard Underground Cable Company, of Pittsburg and New York, made a fine exhibit of samples of their various patterns of the Waring lead covered cable.

Mr. R. S. Waring, vice-president of the Standard Company, opened the hearing in the following words:

"GENTLEMEN: The Spartan mother, in response to the question 'Where are your jewels?' pointed to her children and said 'These are my jewels.' So we point to these specimens of handiwork representing the Standard Underground Cable Co.'s system of electrical conductors, and say, 'These are our jewels.' They have stood the test of time. I prefer, however, that the explanation of the system, the merits claimed for it and the results attained, as shown by the satisfactory working of the cables laid, should be left to those less interested than myself, but who are thoroughly capable of presenting the subject fully and fairly for your consideration. With your permission, gentlemen, I present to you Mr. G. L. Wiley."

[An illustrated description of the Standard Underground cables will be found in the ELECTRICIAN AND ELECTRICAL ENGINEER, December, 1884.—EDITOR.]

Mr. G. L. Wiley said: I have the honor to present a statement and drawings of the underground cable system of the Standard Underground Cable Company for telegraph, telephone and electric light uses. The insulating material used by this company is a hydro-carbon compound of very low specific inductive capacity and the highest attainable insulating qualities—in fact, very much in excess of that practically required in the working of any telephonic, telegraphic or other electrical system. From actual measurements made by Mr. Frank L. Pope for the New York Fire Department on cables of our lightest insulation, the insulation resistance was found to be 946 megohms per mile. The insulating compound being an inorganic substance, there is thus no reason to anticipate any deterioration from time and use, and this has been abundantly proven by the results in the cables of this manufacture longest in service.

Even so good an insulator as gutta-percha cannot be handled without danger at a higher temperature than 100 degrees Fahrenheit, while at a temperature of 112 to 126 degrees paraffine melts. Now, the heat in the steam-heating pipes must be above the boiling point of water (212 degrees), and a temperature much lower than 212 degrees will vaporize paraffine and destroy the usefulness of gutta-percha and most other insulating materials. The vaporizing or carbonizing point of our insulating compound is extremely high, so that cables, the conductors of which have been treated with this compound can, with entire safety, be laid in close proximity to steam heating pipes (a rare and important advantage), especially in New York city, where so many steam-heating pipes are already in use in the principal thoroughfares, and where at any time additional pipes are liable to be laid alongside of existing underground cables.

The Waring Anti-induction Cable.—The Waring anti-induction cables are manufactured in many forms to suit a variety of uses, and may contain any required number of conductors; but whatever the form, the general principle of construction is substantially the same in all. The conductor is first enveloped in a wrapping of fibrous or textile material, which is then saturated and coated with our insulating compound, to which the name "ozite" has been given, and the whole is afterward inclosed in a continuous sheathing of lead, which is pressed closely around the insulated conductors, each conductor being separately surrounded by the metal on all sides. This metallic sheath serves to perfectly screen each conductor from all induced currents from adjacent parallel conductors, making it the only absolutely anti-induction cable and the only cable in which telegraph, telephone and electric light circuits may be worked side by side without interfering the one with the other. The disastrous effect of induction on telephone circuits is so well known that no elaboration is needed. In the Waring anti-induction cable the inductive action from wire to wire is, of course, effectually cut off by the intervening shield of metal, a feature which renders the cable peculiarly well adapted for the telephone service. But not only does the construction of this cable prevent interference from induction in the cable conductors themselves, but also where air-lines are connected to even a short length of the cable the latter is found to eliminate induction.

No underground cable that does not embody this anti-induction feature is adapted for a general underground system, in which telegraph, telephone and other electric circuits may be worked in the same cable.

Branching and Looping.—In any general underground system facility of branching and looping is an important requisite, and this is a special feature in the Waring anti-induction cable. It will be observed that one of the exterior ridges of the cable (sample shown) is somewhat different in section from the others, being provided with a sharp edge or corner which serves to designate the position of one particular conductor throughout the entire length of the cable. The position of one conductor being known, enables the position of any one of the others to be readily

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determined; the principal object of this arrangement is to enable a branch or loop to be inserted into any one of the conductors of the main cable without disturbing the others. The way in which this loop is inserted into the cable will be understood from the samples exhibited; the branch or loop itself is usually a two-wire cable divided at the end for a short distance, as shown, and its conductors spread apart and attached to the severed ends of one of the conductors of the main cable which has been previously opened for the purpose, after which the lead coating is made continuous by a soldered joint similar to that employed in fitting up water pipes.

The cables are made in continuous lengths in the factory, and are divided into suitable pieces, for convenient handling in transportation and laying, and the ends of the sections are united when laid by a simple and efficient joint or splice.

Compactness and Flexibility.—For trunk lines and general street service 2,000 to 8,000 of these anti-induction cable wires (according to the style of cable used) may be laid in a box one foot square. Any of the forms of cable shown above are specially adapted for this purpose, as they are very flexible, are easily and quickly handled, and will pack in a small compass, and their flexibility prevents all injury from the settling of the earth from the effects of frost or from other causes. By using the style of cable shown (an eleven-wire double flat cable), fully 8,000 conductors can be placed in a box or conduit one foot square.

The Waring Bunched Cable.—The Waring bunched cables, are made for telephone and telegraph uses, and any desired number of conductors, up to 100, may be bunched together and covered with a single metallic sheath or lead pipe. In these cables the same high insulation is secured, but the facility of branching and looping, and the entire freedom from induction, are not attained in such perfection as in the Waring anti-induction cables just described.

Electric Light Cables.—The Standard Underground Cable Company manufactures cables of different styles and containing various sizes of conductors and thickness of insulation, both for arc and incandescent electric lighting. (Samples were shown containing conductors composed of strands of smaller wires; their high insulation and non-liability to injury from heating render them peculiarly well adapted for carrying the heavy currents required in arc lighting.)

Conduit.—Many conduits have been invented through which it is necessary to draw the electric cables after the conduits have been laid and closed; but the majority of them seem too expensive for practical use, and there is always danger of injuring the cables in drawing them into the closed conduit. A very inexpensive and serviceable conduit can be made of hard yellow pine with a lifting cover to give easy access to the interior. A conduit of this nature, measuring one foot square inside, would hold from 2,000 to 14,000 conductors. It may be objected that the cables should be easily accessible without again tearing up the streets for branching, looping or increasing the plant. In order to provide for such contingencies, a sufficient number of manholes can be established to answer all purposes of branching and looping, and the low first cost of this simple conduit will permit a saving sufficient to enable the various companies, when laying the conduit or box, to anticipate and provide in advance a sufficient number of conductors for their future needs.

Laying.—The practice in laying this cable has been to dig the trench not over two feet deep, and sufficiently near the surface to avoid gas and water pipes, a foot or two outside the curb; lay the pine trough or box in the bottom of the trench; drive the reels, mounted like hose carriages, along, paying off the cable into the conduit as they move, filling any vacant space in the box with pitch or with earth packed solid; then fastening down the top of the box and filling in the ditch. Not more than one street block needs to be opened at a time, and the work can be very speedily done without interfering seriously with general travel.

Durability and Freedom from Interruption.—Aside from mechanical injury, the length of time which lead will last may fairly be taken as the lifetime of the cable. The cable is not subject to the destroying influences of wind and sleet storms, nor to electrical storms, and communication is never interrupted. Once laid in the earth, it needs no further attention, and the outlay of 20 per cent. per annum required for repairs and renewals of air-lines is entirely obviated.

The workmanship of these cables is of a high standard of excellence; the company's patented processes insure such a high degree of mechanical perfection in its cables as is not attainable by any other process, and every piece of cable, before leaving the factory, is carefully tested, inspected and approved by the electricians in charge. The successful working of all the lines which have been laid by this company is a sufficient evidence of the watchful care which has been exercised.

These cables are no longer in the experimental stage; they have been thoroughly tested for over three years, and up to this time have never failed.

The underground cables of this company are in successful use by the Municipal Telegraph and Telephone Department and by the National Government Departments in Washington city, the Baltimore and Ohio Telegraph Company, the New York Fire Department, the Municipal Telegraph Department of Philadelphia, the telephone companies of Pittsburg and Chicago, the United Lines Telegraph Company, and by the Union Switch and Signal Company, and others on railroads, and in many mines throughout the country, etc., etc.

To summarize, we claim for the underground cables hereby presented:

1st. Extremely high insulation and very low specific inductive and electro-static capacity.

2d. Freedom from induction.

3d. Elimination of induction on through circuits composed partly of air-lines and partly of cables.

4th. Greatest facility of branching and looping.

5th. Ease and rapidity of laying underground.

6th. Compactness and flexibility.

7th. Durability and freedom from interruption when once laid.

8th. The mechanical protection afforded by the lead covering.

9th. Perfection of the mechanical work.

10th. They have stood the test of time.

In conclusion, and in corroboration of what we claim for our cables, we beg to refer to the letters and reports of tests contained in the pamphlet herewith submitted; reports made both by practical and scientific men, many of whom are of national reputation, and many of whom use these cables daily in the transaction of their business.

Among others, who are to-day practically using our cables, are the Union Switch and Signal Company, of Pittsburg, and the New York Fire Department. I understand Mr. Frank L. Pope, now present, is connected with the former company, and I would respectfully suggest that the Commission call upon Mr. Pope for a statement of his knowledge in the premises, and upon superintendent Smith, of the New York Fire Alarm service, also present, for a report of his experience with the Waring cable.

Mr. Pope, at the request of the Commission, stated that he is a director of the Union Switch and Signal Company, who have placed nineteen-twentieths of all the electrical railway signals and switching apparatus now in use in this country. After explaining the system used by the company, and the necessity therein for reliable wire service, Mr. Pope stated that they had experienced great trouble with all the different kinds of wire used until they began to use the lead-covered wire of the Standard company, which had proved entirely satisfactory. Mr. Pope also informed the Commission that he had made careful tests of the Waring cable for the New York Fire Department, which tests had shown a degree of perfection far beyond his expectations. The insulation of the cable, he stated, is of an inorganic nature, not liable to change, and in his opinion this is an essential feature of any successful underground system.

Mr. J. Elliot Smith, superintendent of the New York Fire Alarm Service, informed the committee that his department had used several sections of the Waring cable, varying in length from one hundred to eight hundred feet, for the past eighteen months, and the results have been uniformly satisfactory. The confidence of the fire commission in the reliability of this cable is proven, he said, by the fact that they are about to place all their circuits, 170 in number, underground by this cable, from headquarters outward for several blocks in each direction.

Following Mr. Smith, Mr. W. J. McElroy, electrician of the Standard company, addressed the commission for the purpose, he said, "not of explaining what his company might be able to do in the future, but to describe what they had already accomplished in the past."

Mr. McElroy stated that he had been connected with the Standard company from the earliest hours of its existence, and in his capacity of electrician was thoroughly conversant with all the work done by that company.

The first piece of cable made by Mr. Waring was laid between the Vesta and Brilliant oil refineries, on the Allegheny river, in the early spring of 1882. This cable contained five wires and was a little more than half a mile long. In the fall of 1882 this cable was continued on down to Pittsburg, terminating at a point on Duquesne way, eight miles from the Vesta refinery, the upper end of the line.

This cable worked perfectly for both telegraph and telephone work. Among others who were attracted to Pittsburg by the reported success of the cable, for the purpose of personal examination, and who are consequently well acquainted with the merits of this system, were Messrs. Frank L. Pope, of this city; W. H. Eckert, general manager of the Metropolitan Telegraph and Telephone Co., of this city; W. D. Sargent, of the Brooklyn Telephone Co.; T. D. Lockwood, electrician of the American Bell Telephone Co.; George T. Williams, superintendent for many years of the Western Union Telegraph Co., Cincinnati district; Prof. Dolbear, of Boston; superintendent J. Elliot Smith, of the New York Fire Department; Prof. John Barrett, city electrician of Chicago; Henry Metzger, general manager of the Pittsburg Telephone Co., and David McCargo, general superintendent of the Allegheny Valley Railroad. This cable was laid in the ground without box or other protection, and has suffered considerable damage at the hands of the natural gas pipemen.

The next work done by the company was in Washington city,

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where, in the fall of 1883, they laid for the United States government a line of two cables connecting the capitol, Smithsonian Institution, White House, State, War and Navy departments, and the department of public buildings and grounds, the distance covered being over two and a half miles and the total wire mileage 32 miles. In addition, they laid for the district government a line of 12 wires from the fire-alarm headquarters to their No. 4 engine house on Virginia avenue, and a line of six wires connecting the headquarters with the district building on Four-and-a-half street, the total wire mileage reaching about 14 miles. All of these wires work well and are in daily use. Telegraph and telephone wires are used in the same cable, side by side, without the slightest interference.

The question of connecting air-lines with cable wires having been raised in Washington, as it is everywhere, they made a thorough test of it by connecting one of their cable wires to an air-line running out 18 miles to the Great Falls of the Potomac, and used the telephone with most excellent results.

Captain F. V. Green, assistant to Major Lydecker, engineer commissioner of the district, was present and made a thorough test, and was entirely satisfied with the working of the circuit.

Mr. McElroy continued: "With the kind indulgence of the Commission, I will read extracts from some letters on the subject of our Washington system. Colonel A. F. Rockwell, in his report to general Newton, after describing the Waring system, says: 'These tests and experiments have been numerous and thorough; they were conducted during a considerable period of time and by a large number of persons. The detailed results, interesting and important, are embodied in the various letters which accompany this report, and to which special attention is invited. Their weight and value will be duly estimated, not only by the scientific attainments, but the practical experience of some of the writers. From their consideration, and from my own observations and frequent participation in the tests and practical working for both telegraph and telephone purposes, I express the opinion that the cable laid by the Standard Underground Cable Company fulfills all the requirements of the service as an efficient and practical substitute for the present overhead system.'"

"In a comparative test made between an air-line and this cable, the underground line was very decidedly the better one, being free from *many*, if not *all*, the disadvantages of the old system."—Spencer F. Baird, secretary Smithsonian Institution, Washington, D. C.

"The theory of this cable is scientifically sound. Its anti-induction feature consists in the use of metallic screens between the wires, a device the effectiveness of which was first pointed out by Prof. Henry. In the test made a remarkable freedom from extraneous noises was observed, the articulation, in consequence, being sharp and clear. The Waring cable, both by its excellent insulation, its protection from induction and the facility of laying, admirably fulfills the requirements of a first-class underground conductor."—George F. Barker, University of Pennsylvania, Philadelphia, Pa.

"Special experiments made by me on this cable indicated that when the leaden covering of the cable was grounded, the induction sounds were decreased in volume by about 98 per cent."—S. P. Langley, director Allegheny Observatory, Allegheny City, Pa.

"The wires of this cable connecting some of the government departments are found to be highly insulated, and the practical tests for telephonic purposes were eminently satisfactory. No perceptible retardation or induction."—W. B. Hazen, brig. and brevet maj.-gen., chief signal officer, U. S. A., Washington, D. C.

"The insulation remains perfect on *all* the conductors in the Waring anti-induction cables laid for my department in the fall of 1883, and the entire system works as well as could be desired for both telegraphic and telephonic service. In fact, I have found your cable better adapted for municipal telegraph and telephone service than any other form of cable I have yet seen, for the reason that it may be looped to and from any given point as successfully as air-lines. I have been in the service constantly since the summer of 1868, and in all this experience have not used any system of wires so thoroughly reliable as I find this cable to be."—Henry R. Miles, general superintendent telegraph and telephone service District of Columbia, Washington, D. C.

"As a medium for telephone communication, this cable is, without doubt, the best in the market. The feature peculiar to this cable is its anti-inductive qualities. Telegraph circuits working in the same cable with telephone lines produce no disturbance whatever on the latter, a result which, so far as I know, is attained in no other underground cable. Air-lines of different lengths were connected to the underground wires, not only without difficulty, but with a marked improvement over the all-air line service."—M. Marean, electrician, Washington, D. C.

"In connection with the telegraph service of the Baltimore and Ohio Telegraph Company during the Chicago convention, we used in transmitting bulletins to the White House, the Capitol, and the various executive departments of the government ten and a half miles of the Waring anti-induction underground cable in connection with our direct air-lines to the convention hall in Chicago, and the working of the air-lines and the cable wires was as nearly perfect as could be desired. I am satisfied that this is the best underground system that I have ever seen or tested, and I believe it is the best cable now offered for any use, meeting as it does all requirements of telegraph and telephone service."—W. H. Clarke, manager Baltimore and Ohio Telegraph Co., Washington, D. C.

"Since the Waring anti-induction cables on Four-and-a-half street were connected up on December 12, 1883, they have been in daily use. No complaint of any kind has ever been made as to the service; no message has ever been delayed; no wires have ever been crossed; there is no 'cross-talk' whatever between the wires in the same cable, and none of the buzzing so common with overhead telephone wires. These cables have been in constant use, without a fault, for telephone, telegraph and fire alarm purposes."—F. V. Green, captain of engineers, U. S. A., Washington, D. C.

"The Waring anti-induction cable in Fairmount Park, connecting the Belmont pumping station and Belmont reservoir, was laid October 4, 1884. It has been frequently measured and tested, and the insulation remains as perfect up to this time as when first laid."—D. R. Walker, chief of the Philadelphia Electrical Department, Philadelphia, Pa.

"In all cases where we have used this cable it has proved entirely satisfactory, coming fully up to the claims which you have made for it, and we believe it will prove the most durable underground conductor that we have yet used. This expression is fully carried out in the large orders which we have placed with you recently. We can cheerfully recommend it to parties wishing such conductors, and especially for places where the durability of other wires might be questioned."—The Union Switch and Signal Co., C. H. Jackson, general manager.

"We have, during the past summer, laid in Pittsburg, for the Bell Telephone Company there, more than 200 miles of wire, and in Chicago, for the Bell Company of that city, nearly as much more."

Mr. Shelbourne: Was the cable laid for these two companies of the bunched style or anti-induction?

Mr. McElroy: That laid in Pittsburg was of both kinds, and in Chicago we used all bunched cable. The Washington cables were all of the Waring anti-induction pattern.

To the Commission: As a result of over four years' work, we have cables working to-day, and working successfully, in Pittsburg, Washington, Philadelphia, New York, Chicago and Milwaukee. We have demonstrated the anti-induction qualities of the Waring cable, and its high insulation, and so far as we have gone, have not encountered any of the predicted electrical bugaboos of underground work. The company is willing to guarantee all work, and its guarantee is as good as a United States bond.

As an evidence of the successful working of the cables of this company down to the present day, Mr. McElroy read a number of telegrams just received from parties now using the cables; among others, one from the Navy Department stating that the Standard underground wires were the only ones which had successfully withstood the test of the previous night's storm. Another from Supt. Miles, of the Fire Department of Washington, said: "The Waring cable has worked well continuously since laid, nearly two years ago." Telegrams from the White House, War Department and Smithsonian Institution were of like tenor. A letter from general manager Jackson, of the Union Switch and Signal Company, said: "Your lead-covered cables are giving universal satisfaction in the railway service of the country."

Benezette Williams, of Chicago, submitted plans of a cellular conduit of concrete. It consisted of a solid block or prism, through which were a number of small ducts for the passage of cables or wires. In laying such a system it was necessary to open the street but once. In reply to a question by secretary Moss, he said that it was practically the same as the Dorsett system, but embraced some improvements.

October 14th J. J. Greenough, referring to his plan previously presented, said that he thought more stress had been placed by electricians upon the effects of induction than the facts warranted. He believed that the simplest and most efficient system would be adopted. Whatever might be the final decision of the Commission, he was satisfied that a large number of people would be disappointed.

J. S. DuBois, representing the Manhattan Electric Cable Co. of New York, submitted the plans of a system which had been purchased from the Continental Cable Company. It is to consist of a subway built of brick or asphalt blocks, through which are to be supported sheet metal pipes, having a longitudinal slot along the top of each. Through this slot, cables are to be supported and at the same time drawn into the tubes by an electric railway motor running upon a track at the bottom of the subway. The whole structure is to be hermetically sealed and kept filled with dry air under pressure, the air compressors being placed in such locations as may be found most desirable. The inventor laid much stress upon the virtue of the compressed dry air as an insulator, supporting its claim by the assertion that if it was possible to run a conductor through a vacuum *the electricity*

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would leave the wire. The estimated cost of this system is $20,000 per mile.

October 15th being the last day for the reception of proposed plans for the guidance of the Commission in its work of devising a subterranean system, there was a very full attendance of inventors, experts, journalists and financiers, it having been generally understood that the closing session would bring forward several practical plans, and that the proceedings would be of unusual interest.

D. H. Dorsett, of Chicago, presented samples of his conduit as now used in that city, and which is also being put down in Detroit. Maps and plans were also submitted, and the following history of the material and its introduction for electrical work was given by the inventor and owner:

Gentlemen of the Commission:

"In coming before you at this time to present this system, I will first call your attention to the material of which it is composed, giving to some extent a history of it, which dates back to the fall of 1873. I at that time attempted and succeeded in constructing some service work in the way of sidewalks, using a material composed of coal-tar, sand, gravel and other substances, which up to the present time has proved very successful. From that time until the fall of the year 1877 I gave very little attention to it, but since 1877 I have given my entire time and energies to the production of a material which would prove durable for a sewerage construction. The first work of importance I engaged in after I succeeded in securing this material which you see before you, out of which my conduits with some few modifications are largely made, was the construction of a sewer at the Iowa State Penitentiary at Anamosa, where I put in over 6,000 feet of 12-inch pipe. My next work was in Chicago in the following year—1881-'82. In the fall of 1881 I constructed sewers for the Lincoln Park Board of Commissioners. In the spring of 1883, Professor Barrett, city electrician of Chicago, came to my office and asked me if I would like to have my material tested as an insulator. I told him he might do so, and I broke off a piece of sewer-pipe in my office, and he made some tests with it and pronounced it as good an insulator as he had ever found, and from that time recommended it for the work that it is now being largely used for, and a year ago last spring, having succeeded in getting an appropriation for underground work for the city from the authorities of Chicago, he contracted with me to put up for him this material in the shape of a pipe. Those pipes were made nine inches and six inches in diameter, the trunk lines being nine inches, the laterals six. I commenced the construction in the early spring of 1884. In July following he commenced drawing in his wires, which were single kerite wires, drawing ten and twenty of them half a mile at a time—even twenty different wires without abrasion. Those wires have been in operation from 12 to 15 months without any cost for repairs to the city or any disturbance of any kind whatever, so much so, that in the system which I constructed the past year for the Chicago Sectional Electrical Underground Company, Professor Elisha Gray, president, the city has rented a duct all over the south side, and the wires are now in operation in those ducts. While constructing the system for the city, Professor Gray's attention was called to it, and it was at that time I became acquainted with him. He had then invested a large amount of money in trying to find a successful system, and succeeded in finally getting a franchise which would enable him to put in a comprehensive system for the entire city. We have more or less of the ducts filled with all classes of wires. There are fourteen miles of single seven-hole conduits, covering over about ten miles of streets. It is laid—a great deal of it—double, separating the electric light and the telegraph and telephone systems from each other."

Commissioner Hess—"One conduit?"

Mr. Dorsett—"Two conduits separated by about six inches of earth. One is devoted entirely to heavy circuits such as electric light and power; the other to telegraph and telephone circuits. They are, however, united largely in the man-holes, all kinds passing through the same man-holes at the intersection of the streets. In connection with this subject I would like to spread out the maps showing the system that we have there, and also the extent of its construction."

(Mr. Dorsett exhibited two maps.)

"In Chicago we have the areas or sidewalk vaults which belong to the city, the city owning the entire breadth of the street from building line to building line, and under the franchise we have the use of these areas."

Commissioner Hess—"Where are these pipes laid?"

Mr. Dorsett—"Right along the street, having the same relative position in the street as they have on that paper, the sewer coming in the centre. We get outside the water pipes as we are outside the gas. Our pipes are laid on an average about thirty inches deep to the bottom of the trench."

Commissioner Hess—"You don't have them on both sides of the street?"

Mr. Dorsett—"No; the amount of work which has been done in Chicago I can show by this map."

(Mr. Dorsett laid before the Commissioners another map.)

"These white lines show the extent of the system. We have covered the entire south side as far as Harrison street. This portion of the city is covered so that we reach every block with these laterals. On the north side we have simply run a double line up to Lincoln Park, two miles, and on the west side going over the river."

Commissioner Hess—"Have you an aerial system at all?"

Mr. Dorsett—"No; but we have areas that take care of the entire system. In these conduits are the wires of the Chicago Telephone Company, Postal Telegraph, Western Electric Company, Thomson-Houston, the Mather, the Fuller, the Badger, and the Sperry Electric Light companies, the Mercurial Fire Alarm Company, the Gold and Stock Indicator companies, besides the telephone and telegraph wires belonging to the Police and Fire departments. My system consists of one or more multitubular conduits, with man-holes at convenient distances; it is essentially a drawing in and out system. Its chief merit, perhaps, lies in the material of which it is composed. It is a non-metallic material, which underground is indestructible; it is cheap; it is capable of being moulded into any shape, and it has high insulating properties. It is what is known in chemistry as a neutral substance; it is impervious to water or moisture or sewage. It is impervious to illuminating gas, and sewer gas. It is unaffected by the action of acids or alkalies. It cannot rust; it becomes harder with age. Unlike metals, it is incapable of expansion or contraction by heat or frost. It may be classed amongst the asphaltum concretes, but, unlike the street pavements and sidewalks, and other forms of asphaltum concretes, it is unaffected by the elements, and does not deteriorate through exposure or age. It is the one form of this concrete in a thousand that is a success, and this is largely due to the oxide of manganese in its composition, which appears to be the bond between the other elements combined with it, and yet it is a material which, though the ingredients in their proper proportions are given, requires a peculiar method of admixture to make the compound perfect. I would like to ask Professor Gray to talk a little to you now, and after that I will present the system as I have adapted it to the city of New York to the best of my ability."

Prof. Gray—"*Gentlemen of the Commission:* I do not know that it is necessary for me to add very much to what Mr. Dorsett has already stated. He naturally wants me to say a few words inasmuch as I have been the means of putting this system down, as far as it is put down, in the city of Chicago, and naturally in doing that we have had some little experience. As he stated a while ago, I have spent considerable time and considerable money in studying up this question of underground service for electric wires. It is not a question there and I don't suppose it is a question here, between the relative merits of the overground and underground service, inasmuch as the decision there was to go underground anyhow. The next question came up, how best to go underground. There is no system of telegraphic service, either underground or overground or under the sea, that is free from all objections, and perhaps all systems have some advantages. They all have disadvantages—some of them more than others. The best thing we can do is to get a system that, in our judgment will present the fewest difficulties in accomplishing the work. It is not wholly an electrical question; it is largely a mechanical one, and yet the electrical side of the question must not be lost sight of. After studying the problem my conclusion was that I would prefer a large sewer big enough to drive a four horse team through, that we could get in and string our wires around the sides of it; large enough to take care of all the wires—but that was impracticable in Chicago; I don't know whether it is in New York or not. It may be from a pecuniary standpoint, if from no other; but there we would get so far down below the lake—some 10 or 15 feet, because we have to go about 25 feet down to get clear of water pipes, and gas pipes, and all sorts of pipes that are now in the streets, and I assume that that would be the case in any large city. Besides, it would cost millions—a great many millions—to build such a system.

"Throwing that aside as impracticable, so far as we are concerned at least, the question arose, what comes next? I concluded from my experience as a telegraph man, which dates a long way back of this conduit, that it would not be safe to place any wire underground, or in any position out of reach of repairs.

"Modern improvements in manufacturing wires, and insulating wires, and putting wires in position, are very great as compared with what they were even a few years ago; yet it is not safe to conclude that a great system which has cost a great amount of money should be put in any position that cannot be readily and easily gotten at.

"So then, the next question was to devise something or adopt something that would enable us readily not only to put in wires as required, but to take them out, if necessary. That was the first great fundamental feature of the system, and, as Mr. Dorsett has explained, we have in Chicago adopted what we would call the drawing in and out system; that is, we have provided a conduit, or rather a series of conduits, or a conduit with a series of ducts connected with man-holes. I think the average distance in Chicago is 400 feet. We can draw 600 feet very comfortably of any cable that would fill one of these ducts, as we have frequently

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drawn through one man-hole, two lengths, say 800 feet. It would depend, of course, on the weight of the cable and other things, but we have a system of drawing in and out, machinery for shoving through and catching on to a wire or rope, or whatever we need to handle the cable, with which we shove through at a very rapid rate—perhaps as fast as a horse could trot—hook on to a wire and draw it back, and then hook on to it whatever we wish to draw through; and then by another machine which we employ, when a rope is hitched on to it the cable is drawn through very rapidly, so that I have claimed, and do claim, that the wires as they are now placed in our conduits are as readily gotten at—are as fully accessible as any wires overhead; and they are certainly far more free from any of the difficulties that are constantly happening to overhead wires; because if that wire is once placed in the conduit in a proper cable, properly insulated, it is a very rare thing that it will ever get into trouble. That is our experience from the use of wires now for over two years underground, more or less, in Chicago.

"I do not propose to go into the wire question at all. We have adopted a system like this: We run a conduit system, and let any man who wishes to put in wires, put whatever wires he pleases in there. He may adopt any form of insulation he has a mind to, or no insulation, as one man has done in a single instance, and finds it works very well; but, of course, we do not recommend that. We treat the conduit merely as a receptacle for wires, and we deliver them through streets and into every block. We have laterals running from the main man-holes at the corner of each street, running into the area ways of the various blocks in the city, and from that point the distribution is made for that particular block.

"Now, the question of distribution is one that may be varied, and that is one of the beauties of this system, that it can be adapted to any form of distribution that the circumstances of any particular city may require. Now, we say we have open area ways all around our blocks, and it is a very easy matter when you get into one block to carry a small pipe around under the sidewalks which will be large enough for that block only. No one block can contain a great many wires, so it is an easy matter to provide by a small conduit for distribution.

"Of course we could adopt another method and run a small conduit around every block, and with service wires through area ways. We say that it is not necessary to adopt that, as the other mode is better.

"Another mode is to run into the block and distribute over house tops, if you can make satisfactory arrangements with the owners of the property. Of course there is no objection to that if property owners do not object. In some instances they do that in some blocks in Chicago, for the present, but finally it will come to this distribution system under the area ways, as I think that is the most free from difficulties, and the safest in every respect, and better for the owners of property undoubtedly.

"Our system aims to run down every other street, as you will see. By that means we can touch every block without running in every street, and then an occasional cross conduit cutting all of these through the other way just often enough. It is not necessary to put these through every other street, but every four or five blocks, just often enough to make it convenient to get from one side of the city to the other, and laterally if you want to do it. That is a question that is wholly determined by the need of any particular locality."

"Commissioner Loew—"How large a conduit have you, professor, at any one place?"

Prof. Gray—"We have on La Salle street twenty-six ducts."

Commissioner Loew—"How large is that?"

Prof. Gray—"There we have a ten duct conduit. There is a ten and a nineteen at points like that on Washington street at the tunnel, and La Salle street at the tunnel. Where all the wires must come in to cross the river, we make a larger conduit. We have nineteen holes."

Commissioner Loew—"How many wires are in that? How many will it carry?"

Prof. Gray—"It depends altogether what kind of a wire you are using. One of those ducts can carry four electric light wires, or 125 telephone wires, or 25 telegraph wires. It depends entirely on the thickness of the insulation that the party uses. Mr. Fay, general manager of the Chicago Telephone Company, has some samples which have 125 wires that will go easily in one of those ducts for telephone purposes. I won't say that I recommend that many crowded together, but that is his business, not mine. The Western Electric cable, called the Patterson cable, is made of lead pipe, with paraffine insulation inside. With the size that they make that, the duct will only accommodate four. I am speaking now of electric light wires. So it depends, as I say, upon what you are using wires for, and what the idea is of the man who uses them. I could get one thousand in one duct. You multiply that by the number in any one place and it gives you the capacity. I have no doubt that there are a great many questions that smoe one that is well posted would like to ask on this subject. I probably might overlook points that ought to be brought out, but I would be very glad if any one has any question in his mind that he would ask it."

Commissioner Hess—"What is the strength of that?" (Pointing to section of conduit.)

Mr. Dorsett—"Five thousand five hundred pounds per square inch—crushing strain. The tensile strength averages about 400—about three times that of the best Portland cement concrete."

Prof. Gray—"One of the points in my mind in reference to this material, or anything of the same nature, is the ease with which it could be put in any shape that is desired. Those ducts can be made larger or smaller, as the demands of any particular locality would require. The same principle of operation would form it for one size as well as another, but the object of making the ducts that size was this: You cannot draw in and out wires that are piled on top of each other with any kind of success, if there are a great many of them. Suppose you had a six-inch pipe. Practically, you could not put many more wires in it than you could put in one or two of those ducts and handle them rightly; so that, to use the space economically, it must be divided into ducts about the size you can easily handle in one duct, and that is the object of the subdivision."

Commissioner Hess—"You say you can draw a cable five or six hundred feet through that without injury to the cable, without straining it."

Prof. Gray—"Oh, yes, we have done that. The interior of the duct is very smooth. It is moulded on a polished surface, and, as it is drawn out, it leaves it in practically a polished condition inside."

Mr. R. W. Pope—"You said there were four electric light wires in the duct. Did you mean that was all you could put in, or all that you did put in?"

Prof. Gray—"I mean that in drawing through they put four in a duct—the Western Electric Company. Of course, with a wire made smaller, with thinner insulation than they made, more could be put in."

Commissioner Hess—"What insulation do they use?"

Prof. Gray—"In this particular instance they use what is called the Patterson cable. It is made in a lead pipe. Of course, that lead pipe takes up a good deal of room, and the wire, which is a large wire to begin with, is surrounded by jute; then hot paraffine is injected into this lead pipe until it is filled. All those present who are familiar with electric-light wires understand what the Patterson cable is. There are various kinds of wire, of course, and some with thinner insulation than that, or rather others with no lead pipe, and which, of course, would occupy much less space."

Dr. Moses—"Do those wires go out at the man-holes?"

Prof. Gray—"Yes. At the corner of every street there is a man-hole, and from that man-hole there is what we call a lateral (indicating on the map). These conduits come along here. They all run into that same man-hole."

Dr. Moses—"How do you make your local distribution?"

Prof. Gray—"We leave that question to the wire-users. We deliver them in the block, and charge them so much for the space, or so much for the wire and the distance, and they arrange with the property owners. However, the matter now, as we have arranged to do it, is to control not only that, but to deliver the wires to every building by a small duct, which will run right around the block, so arranged that you can take out wires in any building."

Mr. McDonough—"What arrangement is there for drawing a lead armored cable through the duct, taking the spring out of it if it is rolled from the drum?"

Prof. Gray—"The cable is delivered on a drum. It stands up over the man-hole. Then there is a guide to start the thing. A man stands there and feeds it down and keeps it to the right curve. There is a capstan arrangement situated in the other man-hole opposite the duct, which may be the whole length of two blocks. If the cable is not too heavy we can draw two blocks very comfortably right through one man-hole."

Mr. McDonough—"Is that sufficient to make the cable perfectly true, and have it go in on the line without any spring at all?"

Prof. Gray—"A lead pipe, you know, has no spring on it. It stays where it is put. Of course as it goes in it is straightened. We experience no trouble whatever in practical work. We have put in certainly twenty miles of cable."

Mr. Dorsett—"Would not that be one of the advantages of a small duct?"

Prof. Gray—"Of course you could have the cable so large that it would not be manageable. Any cable that will go in that duct, very readily takes its shape as it goes in."

Mr. McDonough—"The contention I made was that coming into contact with the surface of this hole in the duct you would get up so much friction there that you would not be able to draw it through from man-hole to man-hole?"

Prof. Gray—"The only answer I have to make to that is that we do it. This reminds me of the fellow in jail to whom his lawyer came and said, 'My dear fellow they can't put you in jail.' 'But,' said the man, 'I *am* in jail.'"

Dr. Moses—"When you wish to make a distribution for one particular block do you use a special cable for that block?"

Prof. Gray—"We use whatever wire is needed at that time."

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Dr. Moses—"Do you use the cable specially provided from a central station running from the main?"

Prof. Gray—"We take a wire out from the main at any point we want. Some people put in the single wires, you know. They can draw a bunch of wires through that duct, whatever it will hold, or a single wire, and in that case of course they have nothing to do but just divert that wire into any one of these blocks."

Dr. Moses—"Do you provide for the wants of each block as you reach it?"

Prof. Gray—"We provide the space. We do not provide the wires. We provide the conduit."

Dr. Moses—"I simply wish to know what the facilities may be for supply?"

Mr. F. L. Pope—"Do you have any instance where a small pipe runs from the man-hole to the corner of the block, and different classes of wire are put into the same conduit, electric light and telephone wires for instance, or do you provide two separate channels from the man-hole to the block?"

Prof. Gray—"In some instances there are two separate channels, but in many instances there is only the single 7-hole conduit. That we do wherever it is desirable for any reason whatever to lay two sets of laterals. Otherwise we do not. We have that in some cases; in others we have not. We have conduits all over the city; most of them that size, and we keep all of the electric light wires in one, so far. That was the design to keep the electric light and heavy current wires of all sorts in that set of conduits."

Dr. Moses—"How far apart are they?"

Prof. Gray—"About six inches of earth between the two conduits."

Mr. Dorsett—"It would average about six inches."

Mr. F. L. Pope—"What are the usual methods adopted for making the jointings of the wires in the man-holes?"

Prof. Gray—"Well, in the Patterson cable, which is more used, perhaps, there than any other, whenever they take a wire out they have a mode of sealing the jointing up, and then it doesn't need any protection farther than the ordinary insulation."

Mr. F. L. Pope—"The joint is simply made in the wire, and then the insulating covering is replaced over it in some way?"

Prof. Gray—"Yes."

Dr. Moses—"Is there any delay when a service is asked for in a householder getting it?"

Prof. Gray—"There is no delay on our part. We have four or five electric light companies in our conduits. Now, if a man wants a light it is the company's business to get a light to him, not ours. We charge for the use of the conduit. Then there is a ticker service. We rent them the space in the conduit and they get the wires to their customers. That is a part of the business we pay no attention to. Of course, if it were our business we would see that it was done, but we cannot be a conduit company, and a ticker company, and an electric light company, and a telegraph company, and everything all at once; it is not practicable. The services must be divided up; and that divides it up very nicely."

Dr. Moses—"When you lease your conduits do you do it according to the diameters of the insulation or the diameters of the wires?"

Prof. Gray—"Where we wholesale it we go by the space. Now to answer the question that you will ask me next—we own a certain number of wires for individuals. For instance you have a private wire. You want a single wire. You do not want to rent a whole duct. We take our chances on that and buy a cable and put it in ourselves. We rent you a wire and put it in your office, and wherever you want it from our own cable. We now have one cable in most of that south side system; most of the cases are covered by the various companies, the electric light, the telephone, the telegraph, the district telegraph and the ticker service, and all that are represented by companies, and it is their business to look after their own customers."

Commissioner Hess—"Do you guarantee the effective working of the wire?"

Prof. Gray—"Not at all, only so far as it is affected by the conduit."

"Commissioner Hess—"I mean so far as it is affected by the conduit."

Prof. Gray—"We keep the conduit in order. If the conduit gets broken, or anything of that kind, it is our business to repair it."

Commissioner Hess—"Have you had any complaints as to the unsuccessful working of the conduit?"

Prof. Gray—"We have not."

Commissioner Hess—"How long have you been working it?"

Prof. Gray—"We began laying this system last fall. We have had wires underground there for the past two years. How long ago was it? (To Mr. Dorsett.)

Mr. Dorsett—"A year ago last spring."

Prof. Gray—"These wires have been working since that time. They have now adopted our conduit for the balance of the city. We began renting space as soon as we got the conduits down."

Mr. R. W. Pope—"Practically, professor, how about the joints in these man-holes? Do many of the cables run through, or are they joined up at the man-hole?"

Prof. Gray—"That depends upon the weight of the cable. They aim to draw as long a section as they can, and not injure the cable, so as to have as few joints to make as possible. That is a mere matter of economy with them. With the Patterson cable, for instance, they draw through two blocks without making a joint, but, if necessary, a joint is made in each man-hole. That is a practical question which comes up to the cable men and not to us."

Mr. R. W. Pope—"I wanted to know what the experience was, that was all."

Prof. Gray—"That is about it; in a great many instances they make a joint about every other man-hole, which means every other block."

Dr. Moses—"Have you a system of separate service in each one of these blocks?"

Prof. Gray—"No."

Dr. Moses—"Have you had experience as to running electric light circuits with telephone circuits?"

Prof. Gray—"I know the result of telephone and telegraph service when run near together. Of course, we all know that telephones are more easily affected than any other class of service. There is no difficulty in working electric light and telegraph wires together. There is no difficulty in working electric light wires and telegraph wires in the same conduit, if you will let me put the wires in and fix them as I want them. But as a precaution which any one would naturally take, we prefer to have all the heavy current wires in a duct by themselves."

Commissioner Hess—"You claim you can run an electric light and a telegraph wire in the same duct?"

Prof. Gray—"Oh, yes."

Commissioner Hess—"Without injury to the electric light, I suppose?"

Prof. Gray—"Without any injury to either."

Mr. R. W. Pope—"Are there any wires using the Gray Harmonic system through the conduit?"

Prof. Gray—"Yes; the Harmonic system runs through the Postal cables, and I have worked telephones right inside of that. Of course, if they were exposed, and had no shields of any kind, practically you could not use your telephone at any great distance."

Dr. Moses—"Are the shields grounded?"

Prof. Gray—"Oh, yes, they lie right on the conduit, and as that conduit is iron, they must be grounded very effectually."

Mr. Moore—"In case there should be an explosion of a steam pipe or anything near the conduit, would that cause any trouble?"

Prof. Gray—"It is readily mended. It is the easiest kind of a system to mend in case of an accident."

Mr. Moore—"In doing so, you would have to take out the cable?"

Prof. Gray—"Not necessarily. You can make that in sections, and take one of those sections right out and put it together without disturbing the cables that are in there. It might be advisable, in some cases, if you did not have it full—it might be easier to draw the cable out and draw it in again than it would be to put that conduit in in sections and join it up, but that is a question that I would settle at the time when the accident happened."

A Gentleman—"In Chicago you have area ways in which you lay your pipes. Now, I would like to know how you lay them in New York. Take it down in Wall street, take it in all the lower part of the city of New York—there are no areas there."

Prof. Gray—"Your distribution would either have to be from the distributing pipe in the street, around the block or over the housetops, from the distributing point there."

Commissioner Hess—"Or a court yard."

Prof. Gray—"Or court yards. It is not limited to any one variety of distribution at all. It is a question that has to be settled in every city according to the circumstances you have to meet."

A Gentleman—"Take it where they would have to branch off parallel, 45 degrees or around a corner across the street, how would you get there? In Chicago you have square corners, but New York doesn't have square corners."

Prof. Gray—"Your question is, Can you lay a conduit on a curved street? Why, there is a certain amount of curve that can be put into these pipes, if the curve is not too sharp, but I take it there is no street but that you can meet the objection in this way—you can lay your conduits as far as you can go straight or on a curve, and put a man-hole in there, and go off in the other direction."

A Gentleman—"How would you draw in your cable on a curve?"

Prof. Gray—"We would draw it in. Of course there is more friction on a curve than on a straight hole, though if the curve is down there is not. You could draw a cable that sagged down more easily with a curve than you could with a straight hole. If you were suspending a cable in mid-air it would have a curve."

A Gentleman—"Wouldn't you have trouble with moisture in such a trap as that?"

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Prof. Gray—"I would not have that trap in it. I merely spoke of that for illustration. It would be better to drain toward the man-holes from the centre."

Mr. F. L. Pope—"Your idea is that wherever the curve is too great to draw the cables conveniently, you put in an angle and a man-hole?"

Prof. Gray—"Yes, an angle and a man-hole."

Mr. F. L. Pope—"You have been to Boston, I suppose?"

Prof. Gray—"Well, I have. You can generally avoid a curve there by going through a narrow alley."

Mr. Geo. Worthington—"With the conduits, Professor, that you have described, has there been any trouble caused by sewer gas?"

Prof. Gray—"Not the slightest. The conduits are impervious to sewer gas."

Mr. Dorsett—"I would like to show my plan as I have adapted it for New York. The object of the Dorsett system is to facilitate the laying and distribution of the conductors throughout a city, or any part of the same, to the better insulation of said conductors, and the prevention of inductive or other injurious effects, arising from the close proximity of circuits for different purposes, such as telegraphing or telephoning on the one hand, and electric lighting on the other.

"The system is comprehensive and complete, in so far as it provides for the economical laying and working of all the circuits which the present needs of business and communication require; in other words, it provides for the running in close proximity of circuits for carrying the strongest and most intense currents, as well as those for carrying the most feeble electrical impulses such as are produced in the operations of telephony, and this in such manner that there will be no danger to any circuit from such proximity, while all are brought within ready and easy access.

"The system comprises main and branch pipes, or conduits, in which the conductors are carried in the manner hereinafter specified. The main consists of three separate and independent pipe lines: one containing such wires as are required for communication with distant points, or other cities, and which are designated as trunk lines; another pipe contains the wires of circuits used in local communication, and inter-communications, such as telephone lines, fire and burglar-alarm circuits, and the like; while the third contains the circuits used for electric lighting, transmission of power, or those industrial and domestic applications of electricity which require powerful currents.

"The lines are run through the streets of a city, at such a distance below the surface as will insure protection against bending or injuries from repair of the streets, subsidence of the surface soil, and the like. Generally, and whenever convenient, the lines are run midway between the buildings on either side of the way, and with the trunk line between the other two.

"At the intersection of the streets the three lines are run into what are termed man-holes—that is, subterranean chambers large enough to permit a man to enter them for obtaining access to the pipes, or conductors therein. These man-holes are constructed in a way to keep out water, moisture, moist air, sewage, illuminating and sewer gases, and other matter, and are provided with suitable detachable double covers. The pipes pass through their sides, and the wires can be carried from one pipe to another, as may be required.

"Between the man-holes, and along the blocks, or squares, are numerous subterranean chambers, which are called, or designated, as hand-holes. These are placed as nearly as practicable opposite the dividing lines, between the buildings, so that in places where the buildings are of about the same frontage two hand-holes are required for each group of four houses, as will shortly be explained.

"The hand-holes are for the purpose of running branches from the two pipe lines, on either side of the trunk line, which latter does not pass through them. They are much smaller than the man-holes, though constructed on the same principle. The pipes containing the signaling, and those with the electric light wires, enter these boxes, and one or more of the wires or branches from the same are brought up to a higher level, and taken off into smaller branch pipes to the buildings. Four of the smaller pipes run from each hand-hole, one to each of the four nearest buildings, and in laying the hand-holes and branches it is desirable to locate the former as near as possible to each other in order that all the branches may be placed in laying in one small trench. Of the two branch pipes that run to each house, therefore, one contains the wires of an electric-light circuit, the other those of a telephone or other signaling circuit. In the case of the former there may be one or more leading and return wires for the same house circuit, or the leading wire or wires to one house, and the return wire or wires from another. This is obviously a matter of choice, and not essential to the main features, that of isolating the electric light circuit from the others.

"The material is an insulating compound, containing coal tar, paraffine, silicious sand, pulverized ashes and cinders, oxide of manganese, and ammonium chloride, in certain proportions.

"This material I use for the mains of my system, preferring it to all others. The joints between the sections of the pipes may be either of metal, or the entire conduit may be made from the insulating material alone. I make the man-holes of this material also. The hand-holes are also made of this material.

Inasmuch as the mains are buried deep, and are of comparatively large size, they are advantageously made of the insulating compound alone, but it is extremely undesirable to bury the branch pipes deep, in fact they should be but little below the surface or flagging of the street, and as they carry, usually, only one or two wires, they should be made quite small. Instead of making them, therefore, of the compound alone, I use iron pipes which are filled with the compound, through which passages are formed for the wires. By this means the requisite strength and insulation are obtained.

That section is exactly a duplicate of what we make. The sections are made in my factory at the rate of 1,000 to 1,200 feet a day. They are loaded on the cars as fast as made and shipped to Detroit where I am laying about a mile a week. There are no leaks. I take some of this liquid asphaltum and use it for making the joints. Professor Gray said he did not want the ducts made perfectly continuous: he would sooner have the dry air there.

A Gentleman—"How many wires do you carry through a section of that kind?"

Mr. Dorsett—"It depends on the insulation a good deal."

Mr. Shelbourne—"Is that the patent of August 2d, 1881?"

Mr. Dorsett—"The patent of August 2d, 1881, is the patent on my original material. There is a subsequent patent."

Mr. R. W. Pope—"These pipes are put down in this plan alongside of each other. Can they be put one above the other?"

Mr. Dorsett—"It depends upon the pipes in the streets."

A Gentleman—"Can you give an estimate of what the cost would be of laying it in New York?"

Mr. Dorsett—"I have not made any estimate in regard to that."

George C. Richardson, of Philadelphia, submitted samples of a conduit, containing five ducts, which he proposed to make of sand and cement. After moulding, the sections were submitted to the cold fumes of charcoal, which restored to the cement the element taken out in its manufacture, and left the pipe as hard as the original rock. He proposed a separate pipe for each company with accommodations for as many wires as might be required. He claimed that the joint by which the sections were united was of special merit. One end is concave, and its opposite convex, an annular ring and a corresponding projection giving the joint unusual strength, the whole being covered with a sleeve and securely cemented. The vaults on each block are to be double walled in order to provide an air space around them.

J. J. C. Smith, of the Okonite company, who had previously presented samples of cable, and a sample joint-box, submitted a plan of the city showing the method by which his armored cables were to be laid down in order to accommodate every block. He was followed by Charles A. Cheever, president of the company, who pointed out the economy of the system, as well as the simple manner in which the cables can be laid down, the trench being dug, the reeled cable run over it, and the pavement immediately restored.

Judge Koch, president of the Dock Commission, representing the Wheaton Sub-Electric Company, exhibited a model of an iron conduit, which it is proposed to make 15 inches in width and from 3 to 9 inches in height. Glass blocks about an inch in thickness, with suitable grooves upon the surfaces to admit the wires, are piled one above another after the wires are led through them. These wires were bare as shown in the model, but the inventor stated that if difficulty arose from the condensation of moisture on the glass supports, the wires might be insulated.

John Grieves presented samples of a plan for inclosing individual wires in prepared asbestos paper, embedded in an insulating compound which he stated had been approved by W. H. Preece, of the British government telegraph system.

Dr. Gough, representing the Cogswell Manufacturing Co., showed a sample of Mrs. Cogswell's method of insulation, in which bare wires are cemented between grooved glass plates, which may be packed together and placed in a trench, where it is supposed they will remain forever.

Mr. Johnston, of Philadelphia, representing the American Sectional Underground Conduit Co., of that city, had prepared an extended paper, both argumentative and descriptive, but owing to the pressure of business he was requested by the Commission to confine himself to the conduit proper. He stated that it had been in operation in Philadelphia for three years. That he had brought no samples, for the reason that being in practical use so near New York he hoped that the Commission would personally inspect it. In 1883 they had 249 lights in operation, and the overhead companies had given them but three months to live, but they were still in existence and had 290 arc lamps operated from the conduit. It might be asked why more had not been done, but the system had been offered to telegraph and telephone companies who had declined patronizing them.

The plans and specifications of Thomas G. Turner, were the last which were presented to the board. Mr. Turner has considered the problem as primarily one of civil engineering. He proposes a double route, a main conduit up each side of the city

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(connected across town in the vicinity of Bowling Green and other stated points), which will require laterals of about half a mile in length, the average distance of all instruments being about one-quarter of a mile from the tunnel. Its construction to be similar to that of an ordinary brick sewer(the work to be done by tunnelling), and located below the water pipes, which according to engineering authority is the only available space in most of the streets of New York. The interior dimensions suggested are four feet in height by six in width. The distributing laterals are to be laid just below the pavements, and consist of a core made of terra cotta or similar material with suitable grooves along the sides and top for the reception of cables and wires, which are preferably lead covered for mechanical protection as well as the neutralization of induction. The cables being placed in the grooves, the whole structure is encased in heavy sheet lead. For convenience in gaining access to any wire of a cable at any point, the inventor has devised a cable of such construction that any wire may be selected and led out by opening the covering for a space not exceeding one foot in length. The largest sample distributing case as shown is 5x8 inches in dimensions, having a capacity for 12 cables, and conductors for 400 incandescent lamps and 200 arc lamps. It may be increased in size and changed as to arrangement as the main conduit is approached, and it is obvious that the lead covering may be cut into and connections readily made at any point. The trunk lines are led through the main conduits, in lead cables placed on metal supports, and wherever necessary, branches are taken out at man-holes located at the junctions of the cross streets. The plans presented by Mr. Turner bore evidence of very thorough examination of the territory which it is proposed to provide with electrical sub-ways. He claims that it would be permanent beyond question, and provide for all known service in a practical and thorough manner; and he further claims that as a comprehensive system the cost of plant and maintenance will be lower than any plan offered for the consideration of the board, and that the interruption to the traffic of the city will be avoided by doing the work as proposed, and that three-quarters of all the conductors can be run via the tunnels and therefore are not subjected to the conditions which mainly make underground electrical communication an unsolved problem.

There being no other business before the Commission, the session closed at five o'clock, and such plans only as have been formally presented will be considered by the Commissioners hereafter in executive session. They will visit Philadelphia and possibly Chicago before arriving at a decision upon what system they will recommend for adoption.

ANNUAL REPORT OF THE WESTERN UNION TELEGRAPH COMPANY.

FOR THE YEAR ENDED JUNE 30, 1885.

CAPITAL STOCK.

The capital stock of the company is $80,000,000, of which $20,969 belongs to and is in the treasury of the company. A small portion of the capital stock is still represented by certificates of indebtedness in the hands of the Union Trust Company, in trust for the parties entitled thereto.

BONDED DEBT.

The bonded debt at the close of the year was as follows:

Bonds due March 1, 1900, 6 per cent	$911,250 00
Bonds due May 1, 1900, 7 per cent	4,920,000 00
Bonds due May 1, 1902, 7 per cent	1,373,000 00
	$7,204,250 00
Less balance of sinking funds appropriations not yet used for redemption of bonds held by the Union Trust Company trustees	329,364 34
	$6,874,885.66

During the year, sterling bonds due March 1, 1900, to the amount of £2,100, were redeemed by the trustees of the sinking fund.

BUSINESS OF THE YEAR.

Surplus, July 1, 1884		$4,157,468 89

The revenues, expenses and profits of the year ended June 30, 1885, were as follows:

Revenues	$17,706,833 71	
Expenses	12,005,909 58	
Profits		5,700,924 13

From which there was applied:

For dividends	$4,999,325 41	$9,858,393 02
For interest on bonds	495,072 50	
For sinking funds appropriations	39,991 00	
		$5,534,388 91
Deducting which, leaves surplus, June 30, 1885, of		$4,324,004 11

Represented as follows:

Surplus of net revenue for the year over dividends, interest and sinking funds appropriations	$166,535 22
Surplus at commencement of the year as above	4,157,468 89
	$4,324,004 11

The expenses for the year were:

For operating and general expenses	$8,544,553 79
For rentals of leased lines	1,822,542 58
For maintenance and reconstruction	1,146,871 49
For taxes	301,731 75
For equipment of offices and wires	190,209 97
Total expenses, as above	$12,005.909 58

The above classification of expenses shows that all disbursements for *reconstruction* and repairs, and all payments for leased lines, taxes, and cost of equipments, including the equipment of new offices, have been charged as usual to current expenses before profits are ascertained. Nothing is charged to construction and paid for out of profits but new and additional lines and wires, and buildings, and stocks purchased in leased lines. The cost of a considerable amount of new property such as the equipment of additional wires and new and additional offices with instruments, batteries and fixtures, is every year charged to and paid for as current expenses.

The falling off in gross revenues is due almost entirely to great reductions of rates for the transmission of messages; for the volume of the traffic was greater than that of the previous year. The increase of over twenty thousand messages (exhibited in the table of statistics) shows a very small portion of the actual increase of traffic; as the increased number of leased wires, over which the lessees handle their own messages, takes a very large number of messages out of the count.

The receipts for, and the expenses of, handling domestic messages show that the average rate collected, per message, during the year, was only 32$\frac{1}{10}$ cents per message, against 36$\frac{1}{2}$ cents during the previous year, and 38 cents in the year previous to that; whilst the average cost to the company has been 24$\frac{8}{10}$ cents per message, against 25$\frac{2}{10}$ in the previous year, making an average reduction of 4$\frac{4}{10}$ cents per message, and a difference in the profits of 4$\frac{2}{10}$ cents per message, which, on the volume of business handled, is equal to nearly two and one quarter per cent. on the capital stock.

The loss of 4$\frac{4}{10}$ cents per message as compared with the previous year makes a difference in the gross revenues of $1,852,249,65. Had the reduction been an average of not more than two cents per message, the net results would have been better than the previous year.

The leasing of wires by the company instead of handling the business itself has not proved a profitable change. It has only been done to a limited extent—less than five per cent. of the gross earnings—but sufficient to demonstrate that there is little profit in leasing wires at prevailing rates after paying for their equipment and maintenance.

There has been a falling off in revenues from the gold and stock department on account of the great reduction in the rates for quotation instruments; but there has been an increase in the revenues from leased wires, and from rentals of offices in the company's buildings. The revenues from the company's large investments in telephone and other companies have been well maintained.

GENERAL STATEMENT.

The following exhibit shows the revenues and disbursements of the company for nineteen years from July 1st, 1866:

Surplus of income account, July 1, 1866	$ 275,357 24	
Net revenues for nineteen years, from July 1, 1866, to June 30, 1885	78,080,661 11	
Making an aggregate, June 30, 1885, of		$78,356,018 35

During this period there was applied:

For cash dividends to stockholders (including dividend payable July 15, 1885	44,130,029 58	
For cost of 59,606¼ shares of Western Union Telegraph stock, purchased and owned by the company, which was distributed to stockholders in 1879	3,302,198 90	
For cost of 72,010 shares of Atlantic and Pacific Telegraph stock, purchased and owned by the company, the proceeds of which in Western Union stock were distributed to stockholders in 1881	1,806,250 00	
For interest paid on company's bonds	7,695,803 09	
For cost of 396 44-100 shares of Western Union stock, purchased and owned by company, which were canceled to make the capital stock, after the issue of the new stock in 1881, exactly $80,000,000	26,836 00	
For amount reserved for interest on bonds and for sinking funds, accrued to June 30th, but then not yet due and payable	106,086 64	
		$57,067,204 21
Leaving a surplus of		$21,288,814 14

Which is represented as follows:

Construction of new lines, erection of additional wires, patents, etc	$9,896,160 08
Purchase of telegraph lines, and of the stocks of companies leased by the Western Union Company, upon which interest or dividends are paid as rental	2,448,182 66
Goldand Stock Telegraph Co.'s stock (18,905 shares)	1,176,009 00
International Ocean Telegraph Co.'s stock (15,170 shares)	961,606 24

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Brooks' Underground Telegraph Co.'s stock (1,000 shares)		95,000 00	
Southern Bell Telephone and Telegraph Co.'s stock (1,687 shares)		84,325 00	
Sundry other stocks and bonds		93,739 68	
Western Union bonds, redeemed and canceled		1,389,883 27	
Sinking Funds (portion not yet used for redemption of bonds, exclusive of interest allowed by trustees)		290,567 82	
Broadway and Dey street building	$2,365,639 52		
Less: Amount provided from the proceeds of the bonds	1,802,202 00		
		563,437 52	
Real estate, other than above		283,608 50	
Supplies and material on hand unissued		182,290 08	
Surplus, June 30, 1885		4,324,004 11	
			$21,288,814 14
On account of these assets, a stock distribution was declared in 1881, to the amount of			15,526,590 00
Deducting which, leaves a balance of			$5,762,224 14

Of the $44,130,029.58 paid to stockholders in cash dividends during the last nineteen years, as shown in the foregoing general statement, $22,996,102.24 have been paid in dividends since the consolidation of January, 1881; and in addition thereto, $5,369,-945.11 have been advanced and paid within same period for new and additional properties—making an aggregate of $28,366,047.35 paid out of the net revenues of the company since the date of its present capitalization, and within four and a half years.

From January 1, 1881, to June 30, 1885, $6,369,945.11 were expended for construction and purchase of new lines, and for telegraph and telephone stocks, real estate, and other new property. Of this, $1,229,915.22 (expended between January 1st and September 30, 1881), were appropriated out of the profits prior to October 1, 1881—$1,000,000, were provided for by that amount of bonds sold, and $4,324,004.11 have been advanced (since October 1, 1881) from the surplus June 30, 1885.

The surplus of $4,324,004.11 is that shown in the quarterly statement for June 30th, and represents only the accumulated surplus since October 1, 1881, when appropriations out of earnings for construction and new property were suspended. The moneys necessary to meet these outlays have, nevertheless, continued to be advanced from the treasury as a construction loan to that amount, reserving the right to replace such advances from the sale of assets. The whole accumulated surplus since the capitalization of previous surplus by the issue and distribution of capital stock in January of 1881, is $5,762,224.14, balance as shown in the foregoing general statement. Of this surplus $5,369,945.11 has been invested in new and additional properties, in addition to the $1,000,000 derived from the sale of bonds.

The accumulated balance of $5,762,224.14, shown in the above statement, of which $5,369,945.11 has gone into the plant, is of precisely the same character as the accumulation and investment in new properties of $15,526,590.00 prior to 1881, which, after the most exhaustive investigations in the courts, was finally decided by the Court of appeals of the State of New York to have been legally and properly capitalized by the issue and distribution of capital stock to an equal amount therefor.

STATISTICS.

The following Table exhibits the mileage of lines operated, number of offices, number of messages sent, receipts, expenses and profits, for each year since 1866.

YEAR.	Miles of Poles & Cables.	Miles of Wire.	Offices.	Messages	Receipts.	Expenses.	Profits.
					$	$	$
1866	37,380	75,686	2,250	....			
1867	46,270	85,291	2,565	5,879,282	6,568,925 36	3,944,005 63	2,624,919 73
1868	50,183	97,594	3,219	6,404,595	7,004,560 19	4,362,849 82	2,641,710 87
1869	52,099	104,584	3,607	7,934,933	7,316,918 80	4,568,116 85	2,748,801 45
1870	54,109	112,191	3,972	9,157,646	7,138,737 96	4,910,772 42	2,227,965 54
1871	56,032	121,151	4,606	10,646,077	7,637,448 85	5,104,787 19	2,532,661 66
1872	62,033	137,190	5,237	12,444,499	8,457,095 77	5,666,863 16	2,790,282 61
1873	65,757	154,472	5,740	14,456,832	9,333,018 51	6,575,055 82	2,757,962 69
1874	71,585	175,735	6,188	16,329,256	9,262,653 98	6,755,733 83	2,506,920 15
1875	72,833	179,496	6,565	17,153,710	9,564,574 60	6,335,414 77	3,229,157 83
1876	73,532	183,832	7,072	18,729,567	10,034,983 66	6,635,473 69	3,399,509 97
1877	76,955	194,323	7,500	21,158,941	9,812,352 61	6,672,224 94	3,140,127 67
1878	81,002	206,202	8,014	23,918,894	9,861,355 23	6,309,812 53	3,551,542 70
1879	82,987	211,566	8,534	25,070,106	10,960,640 46	6,160,200 37	4,800,440 09
1880	85,645	233,534	9,077	29,215,509	12,782,894 53	6,948,956 74	5,833,937 79
1881	110,340	327,171	10,737	32,500,000	14,393,543 85	8,485,264 13	5,908,279 72
1882	131,060	374,368	12,068	38,842,247	17,114,165 92	9,996,095 92	7,118,070 00
1883	144,294	432,726	12,917	41,181,177	19,454,902 98	11,794,553 40	7,660,349 58
1884	145,037	450,571	13,761	42,076,226	19,632,939 60	13,022,503 90	6,610,435 70
1885	147,500	462,283	14,184	42,096,583	17,706,833 71	12,005,909 58	5,700,924 13

Attention is called to the preceding table which shows the steady and continued growth of the company. During the year nearly 2,500 miles of pole lines; and nearly 12,000 miles of wire have been added to the plant, and the number of offices has increased to over 14,000, with nearly 23,000 employés. The magnitude of the company's system may be better comprehended when you realize that its pole lines and cables would extend around the globe nearly six times, and the length of its wires would girdle the earth eighteen and one half times.

On account of the general stagnation of trade the year has been a hard one on almost every class of business and every department of industry. Had there been any life and activity in commercial traffic, the lower rates would doubtless have brought us an increase of business more nearly compensating in revenue for the loss by the reduction of tolls. Since the close of the fiscal year on June 30th there has been some promise of a revival of trade which it is believed will bring us largely increased business.

The outlay for construction and new properties during the year amounts to $676,449.88, which is less than has been required in any year for a number of years past. With the extensions of railroads and growing demand for additional wires, this requirement is not likely to be materially reduced. We have thus far been able to meet this outlay from our surplus revenues without interfering with regular quarterly dividends.

The assets in the treasury have been increased by the addition of $40,000, in bonds of the Chicago and North Western Telegraph Company, and $100,000 in the bonds of the Southern Telegraph Company, purchased during the year.

Without a single defalcation, or delay of a single day, this company has during its entire history met the interest on its bonds and those of its auxiliary companies, and paid all rentals of leased lines, whether in form of interest on bonds or dividends on stocks, and whether especially guaranteed or unguaranteed. For a period of eleven and one-half years it has paid regular quarterly dividends, with but a single exception, which was compensated for by an extra dividend within six months thereafter.

Respectfully submitted,

NORVIN GREEN, President.

SUBMARINE BLASTING AT FLOOD ROCK.

Nine years of patient toil under the skilled direction of General Newton and Lieutenant Derby, culminated on October 11th in the breaking up of Flood Rock, which has formed one of the principal obstructions to navigation through the channel at Hell Gate. Although surpassing in magnitude any previous achievement in that branch of engineering, the explosion of 140 tons of dynamite, had been so carefully planned that no unusual results followed the firing of the mine beyond the limits to which its destructive effects were confined.

Electricity was the indispensable agent through which success was attained, yet experience had taught that its use might be somewhat restricted, therefore concussion was depended upon to ignite a large proportion of the cartridges. The advance made in the economical use of battery may be appreciated by comparison with the previous blast at Hallett's Point on September 24th 1876, when 960 cells of battery were used to ignite 25 tons, while on this occasion but 60 cells were required for six times that amount of dynamite.

Preparations had been made at various points within a range of 300 miles to observe the effect of the explosion, but owing to a delay of about 15 minutes in the firing, the indications were not so generally noticed as they otherwise might have been. Two empty carboys which were left on the island, were subsequently found unbroken, showing that it might have been possible for an observer to have remained unharmed upon the little tract of nine acres, which almost entirely disappeared from view. The electrical material used was prepared under the direction of Colonel M. W. Goodyear of E. S. Greeley & Co., and the devices for the explosion were planned by General Abbott, who has given great attention to this branch of electricity. There are so many details to be carefully looked after in an operation of this magnitude, that all who participated are fairly entitled to congratulations upon its unqualified success.

The great advance in the development of instantaneous photography, should also be noticed, as well as the enterprise of the daily press, by which very accurate pictures of the upheaval of the waters, were placed before the thousands of readers of the New York journals on the following morning.

HEWITT AND CLARKE'S TELEMETER SYSTEM.

The enterprise of Mr. Cyrus W. Field and his hearty appreciation of the various uses of electricity, was thoroughly manifested in the fitting up of the Washington building at No. 1 Broadway. The adoption of the telemeter system in its various branches, in order to complete the equipment of such a structure, was determined upon by Mr. Field when his attention had been called to the subject. The telemanometer is perhaps the most interesting and useful part of the apparatus. By its use, the steam pressure may not only be learned at any distance from the boiler-room to which the wires are led, but a complete record of its fluctuations are preserved for future reference. The dial of the steam gauge may be practically duplicated at any distance, and it is obvious that a similar result may be obtained in connection with gauges or dials of any description. At Holyoke, Mass., the height of water in the reservoir of the Holyoke Water Power Co. is similarly recorded in the office, while at the Meteorological station in Central Park, Prof. Draper has for a year past used the telethermometer for indicating and recording

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changes in temperature. A similar application of these instruments is also to be made in the government Bureau of Engraving and Printing at Washington, where they will be required to record the temperature in the various drying-rooms connected with the printing of notes, bonds, stamps, etc.

The perfection to which this system has been brought is such that its future adoption in connection with various industries is merely a question of its becoming generally known. There is little doubt that wherever the consumption of fuel for heat or power is a considerable item of expense such devices soon pay for themselves, besides furnishing valuable data for improvements in the service with which they are connected.

PETITIONING TO VACATE THE BELL TELEPHONE PATENT.

A Washington press despatch says that several petitions have been presented to the Department of Justice asking that suits in equity be brought to vacate the Bell patents now owned by the American Bell Telephone Company. Two of these petitions were presented by the Globe Telephone Company, and the other by the Washington Telephone Company. The Department of Justice has referred the petitions, with the accompanying papers to the Department of the Interior, for the "report, advice, and recommendation of the Secretary of the Interior." The Secretary of the Interior, in turn, has referred each to the Commissioner of Patents for his "report and opinion."

Mr. Montgomery has not yet reported to the Secretary of the Interior, but has submitted to him a brief summary of each case. Secretary Lamar directs and will order that, inasmuch as his "advice, opinion, and recommendation" are invited, he will ask all the interested parties to appear before him and the Commissioner of Patents, exhibit all facts, and answer the following questions :

First, Has the government the right to institute and maintain such a suit for such a purpose? and, second, if it has, do the facts as they shall be presented warrant or demand that such suit be brought? All proceedings will be had publicly.

STORAGE BATTERIES FOR TEMPORARY INSTALLATIONS.

At a recent soiree at Guy's hospital, London, the rooms were beautifully illuminated by Woodhouse-Rawson lamps, the current being derived from Faure-Sellon-Volckmar accumulators, which were delivered freshly charged in the morning. Although the work was merely temporary and but a short time allowed for completion, it was very well done, no wires being visible except where the lamps arranged as pendants hung down from the ceiling suspended by gold and red silk cord. The rooms lighted were as follows :—The Museum of Comparative Anatomy, a building 162 feet in length, was lighted by twelve 20 c.p. lamps, white reflectors being used to great advantage. The new museum was also lighted in a similar manner with nine 20-c.p. lamps. The entrance hall and staircase were very prettily lighted with suspended lamps, floral wreaths being used to form festoons from which the lamps hung. Each of the five rooms of the new ward had a distinctive style of lamp shade in order to harmonize with the decorations. In the first, blue venetian ; in the second, red and white ; in the fourth, white Dalsgrave and flat white opal shades alternately ; the fifth being used as a concert room, red and white shades were used. The centre room was furnished in antique style with special lanterns and electroliers.

The installation was made by Woodhouse & Rawson of London, who also exhibited a large collection of various electro-medical appliances.

UNDERGROUND CABLES FOR NEW YORK FIRE AND POLICE TELEGRAPHS.

The 170 circuits of the New York fire department, radiating from headquarters on Mercer street, are now connected with underground cables leading out for several blocks in each direction. Connections have also been made with Police headquarters by six special subterranean wires, and the Police News Bureau of the City Press Association at 301 Mulberry street, by three wires to each building. The Waring lead covered cable has been used for this work, it having been practically tested by the fire department and found satisfactory after 16 months service in different parts of the city. The recent work, which is the most extensive of its character yet undertaken by the departments, was started Saturday evening, October 24, and continued day and night without cessation until finished without interrupting street traffic. Superintendents Smith, of the fire department, and Crowley, of the police department, expressed themselves as greatly pleased with its successful completion.

DECISION AGAINST EXCLUSIVE RAILWAY RIGHTS-OF-WAY.

A contract between a telegraph company and a railroad company by which it is attempted to give an exclusive right to the former to build and operate a telegraph line over the lines and right of way of the telegraph company and by which the railroad company agrees to discriminate in the carriage and rates of freight against competing telegraph companies is absolutely null and void as being against public policy, according to the decision of the United States Circuit Court for the Eastern District of Louisiana, in the case of the Baltimore & Ohio Telegraph Co., vs. Western Union Telegraph Co.

DEATH OF EDWIN F. LEIGHTON.

Edwin Forrest Leighton who died at Boston, October 13, was one of the old school Morse telegraphers, familiarly known to the craft twenty years ago, as "Ned" Leighton, whose skill as an operator, and gentlemanly traits either in personal association, or over the wire, gave him a high standing among his fellow workers. His fine reputation secured his selection as manager of the Boston office of the old United States Telegraph Co., and subsequently of the Franklin line. He afterwards became night manager of the Western Union office where he remained until he assumed charge of the Baltimore and Ohio office last year. He always manifested great interest in politics, and as a democrat was elected to the legislature several years ago, from a republican district. He has also been elected and re-elected as an alderman, and at his death was a member of five standing committees of the board. Mr. Leighton was a native of Massachusetts, having been born at Lowell, December 8, 1840. He received a good common school education, with an academic course at Westford, and entered the telegraph service at an early age.

DEATH OF WILLIAM C. HICKS.

William Cleveland Hicks who died at Summit, N. J., October 20, has been identified with several important patent suits before the United States courts, as an electrical expert, having appeared in behalf of the McDonough interests against the American Bell Telephone Co., and for the Brush Electric company against Conduit, representing the United States Electric Lighting Co. He was the son of Rev. J. A. Hicks, of Rutland, Vt., and was born in New York, July 21, 1829. He was a graduate of Trinity College, and was the first city engineer of Hartford, having since been connected with various important engineering works. He was also prominent in the affairs of the Episcopal church, and was connected with the revision of the prayer-book.

ELECTRICAL TRANSMISSION OF POWER IN FRANCE.

At the meeting of the Academy of Sciences in Paris M. Deprez on October 27, reported that an experiment for the transmission of electrical power over a distance of 58 kilometres, between Creil and Lavillette, was a complete success. A 40-h. p. current out of 80 had been conducted over the line without the current heating the wire or the dynamo machine. Baron Rothschild paid the cost of the experiment.

ELECTIONS AND APPOINTMENTS.

The annual election of the trustees of the Edison Electric Light Company was held October 27, and the following chosen : C. D. Adams, C. H. Foster, Eugene Crowell, T. A. Edison, J. C. Tomlinson, A. Foster Higgins, E. H. Johnson, F. R. Upton, J. Hood Wright, Erastus Wiman, Spencer Trask, Charles Batchelor and F. S. Hastings.

ELECTRIC LIGHT AND POWER.

Domestic.

The Badger Electric Light Company is about starting its new station in Chicago, the power being supplied by two 150 h. p. Westinghouse engines, with two more to be added shortly.

An incandescent electric light company is soon to be established in New Bedford. The wires in the central part of the city will be put underground.

The Richmond Schuyler Electric Light Co. has been chartered in Richmond, with J. P. Branch, president; Andrew Pizzini, vice-president, and H. M. Sinnell, of Hartford, Conn , secretary and treasurer, to do a general electric light business, capital to be not less than $50,000 nor more than $250,000.

A company has been organized and the necessary capital raised for the introduction of a 600-light incandescent plant at Greeley, Col.

The Daft motor made another trial on the Ninth avenue line October 12th, with two cars and 100 passengers, from 14th to 53rd street and back again.

The Excelsior Electric Light Co., of Baltimore city, has been incorporated with John Q. A. Holloway, John W. McCoy, William A. Hanway and Sebastian Brown, of Baltimore, and Wm. H. Schock, of Washington, D. C., as directors. The capital stock is $300,000.

Foreign.

R. V. Strehleuert & Co., Sodertelge, have just established the first manufactory in Sweden for electric lamps. It is built in

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the American style, and is managed by engineers who have had several years experience in the United States.

The first establishment lighted in its entirety by the electric light in Denmark is the beet-sugar manufactory at Nykjobing, on the island of Falster. The number of lamps is 200, of 16 c. p. each. They are manufactured at Mr. Forgenser's establishment in Copenhagen. The sugar manufactory is only in operation for the winter quarter, but the lamps will be needed from 14 to 16 hours out of the 24.

MANUFACTURING AND TRADE NOTES.

The Westinghouse Machine Co. have recently delivered engines for the following electric light plants:—Badger Electric Light Co., Chicago, two engines of 150 h. p. each; McKeesport Edison Co., fourth order for two of 100 h. p. each; Brush-Swan Co., Norfolk, Va., 75 h. p.: J. C. Reagan, Omaha, two of 60 h. p. each; Kaufmann Bros., Pittsburg, 60 h. p.; Cleveland Electric Light Co., fourth order for 60 h. p.; Ryan Hotel, St. Paul, Minn., 50 h. p.; Duluth Electric Light Co., two of 45 h. p. each; M. Brand & Co., Chicago, 45 h. p.; "Battle of Sedan," Cincinnati, 45 h. p.; John Shillito & Co., Cincinnati, 45 h. p.; U. S. Electric Light Co., Dubuque, 45 h. p.; McTighe Electric Light Co., Pittsburg, sixth order for 35 h. p.; Southern Hotel, Chicago, 25 h. p., also a number of smaller sizes.

Westinghouse, Church, Kerr & Co., of this city, have taken the contract for the motive power in the Edison station at McKeesport, Pa. The station already consists of two 50 h. p. Westinghouse engines, which will now be increased by two more of 100 h. p. each, with proportionate boiler power. Natural gas will be burned under the boilers, the furnaces of which are 40 inches deep below the shells.

E. S. Greeley & Co. have the contract for supplying the telegraph poles along the lines of the Shreveport & Houston and Houston, East & West Texas railways.

The Eddy Electric Mfg Co. of Hartford, succeed A. H. Eddy as manufacturers of the Mather dynamo-electric machines for electrotyping, electroplating, the reduction of ores, etc. The demand has necessitated increased facilities for the production of these dynamos.

The use of electricity for lighting gas, is being adapted to every possible branch of such work by the Electric Gas Lighting Co. of 45 Milk street, Boston, which by the manufacture of first-class goods and sagacious management is placing the business upon a solid footing.

The carbon point manufacturers of the United States met in Cleveland October 29, to form a combination for the advancement of prices.

MISCELLANEOUS.

The Howard Electric Time Co., New York, has been incorporated. Capital stock, $100,000.

RAILWAY SERVICE.

The Liemke Railway Signal Co., Waterloo, Ill., has been incorporated for the manufacture of the electric and automatic signal machines of Herman Liemke; capital stock, $10,000; Spencer Tompkins, William H. Highland, W. C. Rodenberger, H. Olendorph and Fred Joedke are the incorporators.

A very satisfactory test of the Waldermer electric brake has been made recently at Cincinnati. The current is generated by a small dynamo on the engine. The train, consisting of an engine and five cars, was stopped in 700 feet while running down a 68-foot grade at the rate of 45 miles an hour.

THE TELEGRAPH.

The National Printing Telegraph Company is to manufacture, operate, and lease telegraphic instruments, and to build or lease lines. Its capital stock is $1,000,000, divided into 10,000 shares. John Rooney, Abner McKinley, Mark W. Samuel, Samuel V. Essick, George H. Fearon, Louis J. Morrison, and William M. Denman are the incorporators.

The American Printing Telegraph Company has been incorporated by John C. Cruikshank, Lemuel K. McKinney, John S. Silver, Frederick Reed, and William P. Arnold, with a capital of $200,000, to acquire the ownership of telegraph, telephone, electric light, and electric device patents generally. It is to do business throughout the United States, but its main office is to be in this city.

THE TELEPHONE.

It is reported that Prof. J. R. Paddock, of Stevens Institute, has in his possession the original telephonic instruments of Philipp Reis, and has been engaged for some time with other scientists in testing their efficiency.

The Delaware Telephone Co. has been organized, with some of the leading men of the state at its head, which it is expected will lead to an improvement in the telephone service of southern Delaware.

At Evansville, Indiana, in a case where the Bell Telephone Co. had refused to furnish telephones upon applications made by merchants there with whom the agents of the company were not on good terms, Judge Garrett has decided that this is not just grounds for refusal, and that the telephone company is bound by the laws governing common carriers to make no discrimination between the different applicants.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From September 22d, to October 13th 1885 (inclusive).

Alarms and Signals:—*Watch Stand Alarm*, J. Burmann, 327,919, Oct. 6. *Telemetry*, C. L. Clarke, 327,527. *Annunciator*, A. E. Briggs, 327,997, Oct. 13. *Signal and Call Apparatus*, C. A. Smith, 328,148. *Alarm*, G. M. Williams, 328,166. *Telethermoscope*, F. W. Flint, 328,205.

Clocks:—*Secondary Clock Movement*, C. H. Pond, 327,897, Oct. 6. *Attachment for Winding Clocks in series*, same, 327,898.

Conductors, Insulators, Supports and Systems:—*Telemeter System*, C. L. Clarke, 327,526, Oct. 6. *Method of Operating Circuits in Telemeter Systems*, same, 327,657. *Manufacture of Sheathed and Insulated Conductors*, J. Tatham, 327,971. *Conduit*, H. F. Cox, 328,012, Oct. 13. *Structure to Occupy Streets*, R. R. Hazard, 328,027. *Time Signal Transmitting System*, J. M. Oram, 328,055. *Apparatus for Utilizing the Current Force of Water*, E. L. Brady, 328,147. *Junction Between Cabled and Uncabled Conductors*, E. T. Gilliland, 327,080, Sept. 29. *Underground Conduit*, G. S. Cox, 327,383, H. C. Spaulding, 327,466. *Underground Conductor*, Peter Mackin, 327,458, Sept. 29; H. C. Spaulding, 327,480, 327,481, 327,485 *Compound Cable*, same, 327,459, 327,476. *Anchor for Telegraph Cables*, same, 327,460. *Cable*, same, 327,461, 327,491, 327,492, 327,493, 327,494. *Insulating Compound for Cables*, same, 327,462. *Means for Protecting Conductors Underground*, same, 327,463. *Insulated Conductor*, same, 327,464, 327,467. *Means for Protecting Conductors from the Heat of Subterranean Steam Pipes*, same, 327,468. *Composite Cable*, same, 327,472. *Multiplex Cable*, same, 327,473. *Apparatus for Laying Underground Conductors*, same, 327,474, 327,478. *Pipe for Underground Conductors*, same, 327,475. *Splice for Conductors*, same, 327,479. *Conductor*, same, 327,482. *Subterranean Cable*, same, 327,483. *Submarine Cable*, same, 327,484. *Anti-Induction Cable*, same, 327,486, 327,487, 327,488, 327,489, 327,490. *Circuit*, same, 327,495, 327,496, 327,497. *Manufacture of Insulating Blocks for Conductors*, same, 327,465.

Commutators:—*Switch for Motor and other Circuits*, L. W. Stockwell, 326,603, Sept. 22.

Dynamo Machines and Motors:—*Current Regulator for Dynamos*, J. J. Wood, 326,894, Sept. 22. *Dynamos*, R. H. Mather, 326,575; E. Grauert, 327,790, Oct. 6; W. B. Smit and A. Pot, 326,796, Sept. 22. *Motor*, M. Immisch, 327,797, Oct. 6; E. W. Rice, Jr., 328,253, Oct. 13. *Floating Current Motor*, W. Main, 327,888, 327,889. *Current Motor for Dynamos*, same, 328,418, Oct. 13.

Galvanic Batteries:—*Electrode*, J. B. Odell, 327,582, Oct. 6. *Battery*, C. W. Holtzer, 327,878. *Cell*, E. M. Gardner, 328,208, Oct. 13.

Lamps and Appurtenances:—*Incandescent Lamp*, J. Nelson, 327,578, Oct. 6; C. G. Perkins, 326,584, Sept. 22; C. Heisler, 327,795, 327,495, Oct. 6. *Lantern for Electric Lamps*, S. Heiman, 326,979, Sept. 29. *Gas Lamp*, L. Julig, 327,089. *Head Light*, E. B. Cutten, 327,143. *Carbon Holder*, H. H. Levett, 327,282. *Arc* ... *Lamp*, J. G. Allen, 327,375; A. L. Fyfe and John Main, 328,022, Oct. 13.

Measurement:—*Cu*... *rent Meter*, J. J. Green, 327,391, Sept. 29. *Measuring Instrument*, E. Weston, ... 327,908.

Miscellaneous:—*Steam Go*... *vernor*, E. H. Amet, 326,933, Sept. 29. *Water Wheel Governor*, same, 326,934. ... *Process of Manufacturing Permanganates*, T. Kempf, 326,657, Sept. 22. *Att*... *chment for Dental Chairs*, C. A. Eisenhart, 326,357, Sept. 29. *Mercurial Ai*... *Pump*, A. L. Reinmann and C. G. Ott, 327,313. *Hydraulic Lead Press*, J. R... *bertson*, 327,317. *Magnet*, H. C. Spaulding, 327,469. *Machine for Winding Ma*... *gnets*, same, 327,470. *Valve Operator*, C. L. Clarke, 327,525, Oct. 6. *Magnet f*... *or Signals*, W. E. Davis, 327,536. *Bolt Releasing Device*, G. L. Henzel, 328,0... 30, Oct. 13. *Temperature Regulator*, C. A. Tucker, 328,156.

Protectors:—*Safety Device for Circuits*, E. ... Thomson, 327,039, Sept. 29: H. C. Spaulding, 327,498, 327,499, 327,500.

Railways and Appliances:—*Railway*, H. T. ... Clay, 327,381, Sept. 29; R. L. Cohen, 327,382: J. F. McLaughlin, 328,420, Oct. 13. ... *Signal*, F. I. Myers, 327,576, Oct. 6; W. A. Murray, 327,962. *Elevated Rail*... *way*, A. Jackson, 327,690.

Storage Batteries:—E. T. Starr and E. Eugene, 327,31..., Sept. 29. *Cut-Out for*, G. B. Prescott, Jr., 327,964, Oct. 6.

Tools:—*Wire Splicer*, J. A. Helvin and H. Van Hoevenbe... gh, 326,906, Sept. 22.

Telegraphs:—*Repeater for Quadruplex*, G. W. Gardani... r, 326,637, Sept. 22. *Telegraphy*, W. Maver, Jr., 326,880. *Means for Preventin*... *g False Signals on Reversals in Quadruplex*, F. Van Rysselberghe, 326,892. *P*... *rinting Telegraph Receiver*, C. M. Jordan, 326,989, Sept. 29: A. Wirsching, 327,... 911, Oct. 6. *Submarine Duplex*, A. Muirhead, 327,097.

Telephone Systems and Apparatus:—*Switch*, C. Whittle... ck and A. C. Knapp, 326,610, Sept. 22. *Magneto Telephone*, J. H. Rogers ... and J. Webb, 326,675. *Toll System*, H. Edmunds and C. T. Howard, 32...7,073, Sept. 29. *Auxiliary Mouth-Piece for Telephone*, C. A. Harrison, 327,3...3. *Telephone*, H. E. Waite, 327,625, Oct. 6. *Arm Rest for Telephone User*... s, F. G. Johnson, 327,692. *Telephonic Apparatus*, S. P. Thompson, 327,8...7. *Magneto Telephones*, J. F. Cole, A. H. Low, 327,887. *Line Wire for Mechanical Telep*... *hones*, J. F. Gilliland, 327,940. *Acoustic Telephone Exchange*, 328,243, Oct. 1...3. *Mechanical Telephone*, F. R. Shaw, 328,258. *Exchange System and Ap*... *paratus*, L. B. Firman, 328,305.

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NEW YORK, DECEMBER, 1885.

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THE PROCEEDINGS AGAINST THE TELEPHONE PATENT.

IT was stated in our last issue that a number of applications, including a new one of the Pan Electric Telephone Company, the Globe Telephone Company, and divers others had been made to the attorney-general for leave to file a bill and bring suit in the name of the United States to cancel the 1876 patent of Alexander Graham Bell, known as the telephone patent. A bill was prepared by the counsel of the first named company at Memphis, and permission is asked to file this and other bills. The petitions having been referred to the department of the interior, a hearing was ordered by the secretary of the interior on October 31st at Washington, and on that day the counsel of the petitioners and of the American Bell Telephone Company appeared before secretary Lamar. Finding that the question to be discussed was likely to cover an extensive field of inquiry, the hearing was adjourned by the secretary until November 9th, when it was resumed, and thereafter occupied a full week. At the hearing, the counsel for the several petitioners put in their evidence in the form of numerous affidavits, to which the respondents, the American Bell Telephone Company, presented other affidavits in reply. The case was then argued at considerable length by the counsel on both sides.

The questions actually at issue in this contest are of the most vital importance to inventors, patentees and manufacturers, and may be formulated substantially as follows: First; Has the government the constitutional power to cancel a patent in any case; and, second; Assuming such power to exist, is the case now presented by the petitioners a proper one for its exercise? The grounds alleged by the petitioners for the cancellation of the Bell patent, as nearly as we are able to discover from the verbose, rhetorical and more or less contradictory allegations in the Memphis bill, are, first, irregular and fraudulent procedure in the patent office, whereby Bell obtained an unlawful knowledge of the contents of a certain caveat in the secret archives of the office, and interpolated the same into his own specification, thereby securing a patent in fraud of the rights of the real inventor; second, want of novelty in the apparatus or method by reason of the same having been invented by Philipp Reis, Antonio Meucci, and others, facts alleged to be well known to the applicant and to the world, but fraudulently concealed by him from the officials of the patent office and, third, collusion between the professedly opposing parties in the litigation of suits brought under the patent, and also in interference proceedings before the patent office, in which the title of the patent was involved, whereby the courts and the patent office have been induced to render improper and unjust decisions in favor of Bell. A great number of affidavits were presented by the counsel for the various petitioners, by which these charges were attempted to be substantiated. It may, however, be said at once that no proof worthy of a moment's consideration was presented tending to support the charge of fraud in the patent office. As to the question of want of novelty, no evidence was presented other than that which has repeatedly been considered by the circuit courts, with the exception of the affidavits relating to the claims of Meucci, which have not, we believe, been judicially passed upon. The evidence tending to show collusion was of little importance, with the exception of the affidavit of Professor Gray, and even this stated in substance little more than his own personal opinion on the subject; all the facts set forth by him in support of that opinion being already well known to those familiar with the course of litigation which has arisen under the Bell patent.

A review of the proceedings at the hearing, of which we give a very full abstract in another part of the present issue, shows in the strongest possible light the utter absurdity of attempting to determine the question of the validity of a patent by a proceeding of this character. The counsel for the petitioners, among whom were gentlemen of acknowledged learning, eloquence and ability, were placed at a manifest disadvantage by reason of their entire lack of familiarity with patent law and practice and with the technical procedure of the patent office, from which it re-

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sulted that a large share of the evidence introduced by them, and of the points made in their arguments, were entirely foreign to the real question at issue. The counsel for the respondent, on the other hand, are well known to rank among the foremost, if indeed they are not the very foremost patent lawyers in the country. Secretary Lamar, who presided at the hearing, is a statesman whose learning and ability are too well known throughout the length and breadth of the United States to require any endorsement at our hands, and while scarcely any person could probably be found better qualified to appreciate and to pass upon the great constitutional questions involved in the case, yet as he himself frankly admitted, he possessed but little knowledge of the principles and practice of the law in reference to patents for inventions. It resulted from this state of affairs that the arguments of the counsel for the petitioners were, almost of necessity, devoted largely to vehement and vague denunciation of the "telephone monopoly" and of the personal acts of the inventors and patentees whose labors have given value to the property of the Bell company, based in a great measure upon a total misapprehension of the true bearing and relations of the evidence which they themselves had presented, so that at times a hearer was irresistibly reminded of the argument of Sergeant Buzfuz in the case of *Bardell* v. *Pickwick*. But in making a concerted attack upon the professional honor and integrity of the different counsel who have heretofore been employed against the Bell patents, particularly in the Dowd and Spencer cases, and in the interference proceedings before the commissioner of patents, the petitioners have transgressed the limits of ordinary decency. The case must be desperate indeed in which it becomes necessary to resort to measures of this kind. It may be that before these proceedings are ended, names hitherto honored among their fellow men will be covered with reproach, but we are not yet ready to believe that such men as George Gifford, Frederic Betts, or William Baldwin, will be found in the list. The main argument of the respondent was directed to the fundamental point of the unconstitutionality of the entire proceeding, and was pronounced by all who listened to it to be an able and convincing, if not unanswerable, presentation of that side of the question. The argument in defense of the essential novelty of Mr. Bell's invention, and in justification of the decisions of the United States courts which have been attacked by the petitioners, was also a remarkably effective one. It is not probable that a decision will be reached by secretary Lamar before we go to press. The petitioners profess great confidence that the result will be in their favor, but they nevertheless are understood to admit that they have received no intimation which would justify them in making a positive statement to that effect.

An important question may arise, in case it should be decided that suit may be brought in the name of the United States, as to whether the government or the complaining parties shall defray the expenses of the litigation, which will necessarily be very great. It was stated officially at the hearing, that the legal expenses of sustaining the Bell patent had already amounted to considerably more than half a million dollars. It is believed that the department of justice has no fund at its command which is available to defray any considerable expense arising from such litigation, while on the other hand there would seem to be a manifest impropriety in any arrangement whereby the counsel appearing in behalf of the government should receive their compensation from private parties. This however is only one of the numerous perplexing questions which are likely to arise in case these proceedings are carried beyond their present stage.

THE CONSENSUS OF THE INCOMPETENT.

A WOULD-BE sporting character, upon being asked why his horse did not trot a mile in 2:20, replied that there was only one difficulty, and that was that the time was not long enough for the distance. We respectfully commend the logic of this gentleman to the attention of our esteemed contemporaries who are indignantly inquiring why the electric wires in this city were not placed underground prior to November 1st, 1885. There is a certain class of people in the community, who not only believe that any end whatsoever can be attained by a sufficient expenditure of money, but that the time required to prepare the plans or to execute a work of this character, is a factor wholly unworthy of consideration. With a sufficient number of gardeners and an unlimited supply of fertilizers, they might with just as much reason expect to plant and harvest a crop of potatoes within twenty-four hours. Interested parties who have been actuated by selfish motives in their endeavors to force the electrical companies to bury their wires, are now equally anxious that their own particular plan should be adopted without discussion or delay. The persistent agitation of these parties, has, as they suppose, alone urged the movement forward step by step, and now, late in the fall of 1885, they anxiously inquire through the press, "why still delay?"

In the first place the Daly act of 1884 was notoriously defective in its provisions, a fact which was repeatedly pointed out by the electrical press. The supplementary act of 1885 by which the existing subway commission was created, although an improvement in some respects, merely authorized the board to receive plans from the existing electrical companies for the burial of their wires, in default of which the commissioners were empowered to "devise" plans of their own to carry out the provisions of the law. No limit of time is set for the completion of the "devising," in which work the commission is now engaged. Every electrical engineer had recognized to a greater or less extent, the formidable obstacles which must necessarily be encountered in perfecting a subterranean system suitable for the accommodation of all branches of electrical service in this city. The professional opinions of these experts, were, however, hastily assumed to have been given in the interests of the companies owning overhead wires. It may have been for this reason in part, at least, that three gentlemen were appointed on the commission who were presumably unprejudiced, and who at the time of entering upon their duties professed no technical knowledge of the subject.

After giving ample notice to the companies to file plans, the commissioners gave public notice that the plans of "inventors and others" would be received for consideration, the time being finally extended to October 15th. An undertaking of this character ought never to be actually begun

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until a thorough investigation of the subject, has been made, and this is what we are assured will be done before a decision is reached.

The cities of Philadelphia and Washington have been visited in search of information, as a popular superstition exists that all electric wires are underground in those cities as well as in London, still it is doubtful if either of them contains as many miles of subterranean line in successful operation as exists in the city of New York to-day. Chicago is generally believed to offer the only example of an extensive and well organized system of underground wires, embracing all varieties of electrical service, and after the examination of this is completed, the entire field of practical and theoretical subterranean work, so far as this country is concerned, will be taken up for final consideration in connection with the requirements of New York.

The work that is being done in Brooklyn, however suitable it may be for that city, is not applicable to the important thoroughfares of New York, as it is not feasible to permit each company to lay down an independent conduit. This has been done heretofore, but to continue the granting of such franchises would without question ultimately lead to a complication of subterranean work which would be even more annoying than the present condition of affairs above ground, respecting which so many complaints are made.

PROFESSIONAL ELECTRICAL ENGINEERING.

The attention of our readers is directed to an article in another column which we reprint from the London *Electrician*, showing the illusory ideas prevailing in England as well as this country regarding the openings awaiting the trained electrical engineer, and the fabulous salaries attached thereto. The graduates of scientific schools who have pursued a course of electrical study are frequently disappointed at their reception by the cold world, and we have heretofore reminded them that their training should be considered an apprenticeship rather than the attainment of thorough practical knowledge of the profession. It is also well to add that at the present time the opportunities for engagements at a liberal compensation are by no means plenty, even for the best practical men. The development of arc lighting, telephoning and telegraphing offer few inducements to electricians. The future of incandescent lighting and the transmission of power is more promising, for the reason that such work must be planned and executed with scientific accuracy in order to lead to commercial success.

It is but a short time since the public interest in electrical development was awakened, soon followed by the establishment of courses of electrical engineering in various colleges and universities. The apparent demand for trained electrical experts was succeeded by a reaction when it was discovered that an ordinary machinist's apprentice at a dollar a day, or the steam engineer already employed for service in his own line, were equally capable of acquiring the necessary skill to operate the average electric lighting plant. The installation could be entrusted to the management of the manufacturer's agent and the casual lineman, with whose profound knowledge of electricity in all its branches most of us are familiar. Subsequent success depended upon the care with which the combustion of low-grade fuel was conducted in order to produce the most power for the least money.

This is the field in which electrical engineers are expected to find employment, and it appears doubtful whether it will be sufficiently extended in time to provide for the vast number of graduates who will be from year to year added to the existing supply.

Notwithstanding this condition of affairs, we are well aware that the scientific training of these young men is of great value, and in many cases proves a most important factor in leading up to a successful career, yet it will not remove all of the many obstructions which continually beset the path of the struggling wayfarer.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

A general meeting of the Institute will be held at the rooms of the American Society of Civil Engineers, 127 East 23d street, New York, on December 8, at 1 p. m., for the purpose of making certain amendments to the by-laws which have been prepared by a committee appointed for that purpose. As the points involved are likely to draw forth considerable discussion no papers are expected to be read, although if time permits there are various questions which may properly be brought up.

The endorsement of a universal wire gauge, if such action was in the direction of a reform, would doubtless give encouragement to those who have already devoted attention to this subject. Members and associates who propose to attend should be prepared to give as well as receive information, for it is the mutual exchange of ideas and experience which gives practical value to an organization of this kind.

The careful guarding of trade secrets is less commonly practiced than was the case previous to the advent of technical literature. The individual who is capable of inventing new methods, and practically applying them to advantage, gains a prestige among his fellow craftsmen which eventually proves of greater value, and gives far more satisfaction to the originator than the monopoly of a mere idea, which is liable at any time to be rendered valueless by the introduction of new processes. It is quite noticeable that many gentlemen well versed in electrical science, apparently prefer to present their views before organizations which are not strictly devoted to the subject. Many of these societies are older, and perhaps more widely known than the Institute, but we doubt if the benefits either given or received, are equal to those arising from association with actual co-laborers in the same field.

THE PHILADELPHIA DYNAMO TESTS.

The final results of the exhaustive tests of dynamo machines in connection with the Electrical Exhibition last year, have been published by the committee, and the report is a most important contribution to the investigations in this branch of the science. It was our intention to review the valuable work performed by the examiners, but as only a portion of the report could be published in the present issue, we have deferred our comments until its completion in the January number. The electrical community would no doubt be more thoroughly satisfied had there been a greater variety of dynamos in competition, as it is a most difficult matter to secure accurate tests, made under equitable conditions, the results of which may be accepted without question.

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ARTICLES.

THE CONSTRUCTION OF LINES FOR ELECTRIC CIRCUITS.

BY THOMAS D. LOCKWOOD.

(Concluded from page 418.)

JOINTS in cables are by those who have to make them, technically called "splices," and making them may be divided into several complete processes, *i. e.*, joining the conducting wire; joining the insulation; joining whatever hemp, rope or other packing there may be; and finally splicing the armor. Happy is the cable constructor who does not at some point or time have to make a joint. I shall not attempt here a detailed description of the methods to be adopted in jointing rubber or gutta-percha cables, as it would necessarily be a transcript of what has already been fully described in many text books, but better I think in Swift's Practical Telegrapher, than anywhere else.

As the text books, however, devote their energies chiefly to jointing the insulation and armor, I have thought it well to devote a short space to the conductor joint. Where the conductor is composed of strand wires, these are first soldered together to form a solid wire, and the two ends are then scarfed down by filing as in the figure below, in which the two ends are shown as they appear after they are put

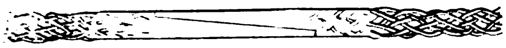

FIGURE 28.

together. When the two scarfed surfaces are thus joined, they are served with copper wire about No. 22 gauge, and the whole is once more soldered. Another serving of copper wire is then applied, extending beyond the first, and soldered at its ends only, so that if the joint opens out, the electrical continuity will still be maintained.

Another joint which is stronger although not so short or so neat, is made as follows:—The two lengths of cables to be joined are each given two or three twists by coiling on the floor, and the several wires of the strand being then unreeved, are each separately joined to a strand on the other side by scarfing as in the former case, and so as to break the joints, and two or three extra twists are then given to the entire joint by straightening the cable.

This splice takes a considerable length of bared wire; and cannot be employed in cables having single conductors. Joints for paraffine cables are referred to in the prior article on aerial cables.

UNDERGROUND LINES.

There is now so much public feeling upon this subject, and it is so freely canvassed by the daily press that to leave it without reference in this series of articles seems to be hardly prudent. It is by no means a new idea to lay electric wires below the surface of the earth.

Morse made his first attempt at electric telegraphy, with underground wires; Wheatstone and Cooke also attempted so to lay them.

Ronalds as early as 1816, laid electric wires encased in glass tubes in his garden, and passed messages through them.

The early attempts at burying conductors all however failed through defective insulation. There are at the present time several systems of telegraph working over underground wires, although complete telephonic systems with the exception of that of Paris have not as yet come into existence. There are a number of different plans for laying wires underground, and several hundred patents on the subject, most of which, however, relate to mechanical details of conduit, and arrangements for supporting the wires.

One well-known plan for burying telegraph wires is the one adopted by the German government for its telegraph lines. This is to prepare armored cables enclosing the required number of electric conductors, and to bury the cables direct in the earth without any boxing or troughing whatsoever. The German cables each contain seven copper conducting strands of 90 pounds to the mile, and insulated with gutta-percha weighing 76 pounds to the mile. The seven wires, each insulated, are placed in an armored sheath composed of 24 galvanized iron wires each about one-tenth of an inch in diameter. The weight of the iron is about 4,080 pounds per mile. The iron armor is then wrapped over for protection against oxidation, by jute impregnated with a bituminous compound. The entire weight of these cables is about 6,100 pounds per mile, while the breaking strain is four and a half tons.

These cables seem well adapted for their purpose, and if properly made at first, with regard to insulation, ought to be very durable. The operation of fast systems over them is perceptibly impeded when the circuits are long. But I think them, nevertheless, the best form of subterranean wires for long lines.

A second method which has been proposed, is to build chambers or vaults below the surface, and connecting each two chambers by iron tubes, pass insulated wires or cables through the tubes. This is the most expensive way—although perhaps the most durable. This is substantially the method adopted by the British telegraph department in passing their wires through the London streets, although instead of vaults, test boxes only, are used.

Still a third way is to dig a ditch of suitable depth, and laying an open box therein, stretch lead covered cables in the box, cleating them down, and finally to fill up the box with pitch, and then nail or screw down the cover, and fill up the ditch. The cables are thus led underground to suitable points where they emerge, and from whence their wires are distributed to their various points of destination.

This method may be varied by cleating the separate wires instead of the cables, but the results are by no means so satisfactory as the heat from the melted pitch is apt to run them together. Still another way is to take a multiple conductor cable heavily covered with lead, and to bury it without either box or armor. This answers well for short telegraph lines, but must not be laid in clayey soil, as the lead in such soils undergoes decomposition.

Each of these methods is much more expensive in first cost than an overhead system of equal capacity, and when they are used for any length with fast sending systems are harder to work over, and diminish the speed of working materially.

For private Morse lines, of no great length extending between few stations; for private telephone lines of not more than a mile or two in length, underground lines when well insulated answer well.

If I were running a line between a house and stable, or between two adjacent residences, for such purposes I would prefer the underground plan every time.

Where several lines are to connect the same points, a lead covered cable buried with or without boxing will do. For a single short line, not exceeding a couple of hundred yards, lead covered kerite or rubber covered wire is the best to use.

Wires centering at telephonic exchanges are not conveniently placed underground, as the retardation due to static induction shows itself on very short lines, and makes the talking very indistinct. This is quite perceptible even on a half mile line, and is much emphasized when a long line is connected thereto.

It is not likely that systems of telephone wires, and district messenger call wires can ever be placed entirely underground even though the electrical difficulties in the way should be totally eliminated, as the mechanical obstacles are almost insuperable, since the wires have to be brought out and distributed so frequently.

NOTES ON SOLDERING.

I have made frequent mention of soldering in the course of these articles—and it may perhaps not be amiss in con-

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clusion to give a few hints on the necessary manipulations.

Soft soldering is that which is most generally applicable, and from the low temperature at which the solder fuses, it may be used in connection with almost any metal. The surfaces to be joined must first be cleaned. Iron and copper may be cleaned with a file or knife, or with emery paper or acid.

Lead, tin and pewter, may be scraped. Tin-plate and thin metals, may have soldering fluid placed on them and the solder then applied directly. Thicker masses of untinned metal, especially iron, should first be tinned by the application of a little flux, and a dipping in the solder.

When convenient the quickest way is to have the solder all ready melted in a ladle or melting pot, and to dip the fluxed joint completely into the fused mass, rubbing the solder well into it with the soldering iron. Taking it out, the joint may be squeezed a little to remove the superfluous solder, and then allowed to cool.

When a splice is so placed that it cannot be dipped; the flux may be first applied, and some small pieces of solder placed on the joint, and wrapped round with tinfoil, after which the flame of a Bunsen's burner may be, by means of a blow pipe, directed on the joint.

THE END.

LIABILITIES OF TELEGRAPH COMPANIES AS AFFECTED BY PRINTED CONDITIONS.

BY J. P. KIRLIN.

PART II.

In the November number of this review (at page 424), I dwelt on the question how far a telegraph company, by conditions in its blanks, can limit its liability for mistakes and delays in the transmission or delivery, or for non-delivery of messages, whether happening by negligence or otherwise; and presented the divergent views of courts of high authority upon that mooted subject. It was premised that such a company might, by special agreement with those who employ it, make reasonable rules and regulations regarding the operation of its lines, and that those regulations might sometimes work an exemption of liability for damage in some jurisdictions even when the loss occurred through negligence; that the sender of a message is not bound to comply with any regulation or accept any condition operating as a waiver of his right to proceed against the company, unless he chooses; and that he can, by process of law, compel the company to make an unconditional contract, under which the correct transmission of his message is insured. But the annoyance and expense of such a proceeding, and the desire to use the wires at once, usually deter employers from availing themselves of this right. They contract subject to the conditions imposed, and take the chance of overthrowing them in case the messages are improperly delivered. Assuming, then, that the contracts are so made, it is the purpose of this paper to examine into the force of certain other of these conditions.

1. A common provision is that "no responsibility regarding messages attaches to this company until the same are presented at one of the transmitting offices; and if a message is sent to such office by one of the company's messengers, he acts for that purpose as the agent of the sender." Applying the test of reasonableness and fairness to this clause, the courts allow it to be valid. It is a precaution that is wisely taken. The transmitting agent is possessed of information respecting the lines, which is wholly without the knowledge of a messenger, and it may be desirable for him to inform the sender of accidents and obstructions, making delay unavoidable, by reason of which a change of the terms of the contract is rendered necessary. So, also, he should be given an opportunity to obtain from the sender, whatever information he wishes respecting the message, and, if a breach of the contract be probable, the amount of damages such breach will entail. Reason and authority both make in favor of upholding this condition, and as pains are taken to have transmitting offices everywhere accessible, it appears to be without serious objection.

2. A regulation requiring the sender of a message to disclose its true import, is deemed to be unreasonable, and cannot be enforced. It cannot be claimed that a full knowledge of the meaning of a message is requisite to its correct transmission. All that an operator requires is plain words, plainly written. To allow the enforcement of such a regulation, would be to encourage agents in impertinent inquiries relative to private affairs; and moreover would operate as a serious check on the free communication of intelligence. A company cannot require such a disclosure even where it is suspected that a message is immoral in its purposes, if it be not immoral upon its face. It has been held that there is no provision of law which authorizes a telegraph company or its agents to question or impugn the motives of anyone who might wish to transmit over its wires, a message couched in proper and decent language. And there is certainly no law which constitutes the agents of a company the censors of public morals, or permits them to pass upon the good or bad faith of individuals who choose to forward dispatches over its lines. If only the message be couched in fair language, the duty of the telegraph company, on payment, or tender of the legal tariff, is clearly fixed by law. It has no discretion but to send the message. If, however, it be expressed in obscene or improper language the company is excused from the duty to transmit.

3. A regulation that messages will not be received in time of strikes, except subject to delay, may or may not be valid according to circumstances. If the company, from such a cause, is induced to limit, in some public manner, the scope of its business, and if in a reduced sphere, it serves fairly those who wish to employ it, it may refuse to send a dispatch, save subject to delay, by reason of this clearly specified cause; and will not be liable to an action for such refusal. But inasmuch as the primary function, indeed the *raison d'être* of a telegraph company is to effect the rapid transmission of intelligence, any stipulation or exemption in derogation of this purpose, must be specifically stated. It cannot, accordingly, demand to send "subject to delay," simply. This expression is broad enough to include wilful, or negligent delay, either of which does violence to the very nature of the company's calling.

4. A condition that "the company will not be liable for damages in any case where the claim is not presented in writing within sixty days after sending the message" is everywhere upheld as reasonable and valid. There are strong considerations in its favor. It must be borne in mind that it does not debar the sender from bringing his suit any time within the period of the statute of limitations (usually six years). The company only demands that it be advised of the existence of a claim, with particulars of its extent, while the transaction is still fresh in the minds of all concerned. It may easily happen in a large office, where much business is done, and the help frequently changed, that in a comparatively short time the circumstances attending a particular transaction would sink into oblivion, and the defense of a stale claim thereby made practically impossible. Moreover, the companies are often willing, for business reasons, to pay a clearly established loss, and therefore claim to be informed thereof at an early day, in order to conduct their own investigations and discover where among their employés the blame is to be placed. As it simply requires the exercise of that diligence which an ordinary individual would naturally show in a case of real damage, there can be no well sustained objection to its fairness, while from the sender's own standpoint there is much to be said in its favor.

5. A condition that the company will not be liable in

case of mistaken delivery, or for non-delivery where occasioned by negligence, we have seen is destructive of the agreement to transmit and is therefore inoperative. The essence of the company's agreement is to deliver the message promptly, and to the person to whom it is addressed. Diligent efforts must therefore be made by the company's agents to find the right person ; and if these fail, the message must be mailed to him at the address given ; it being presumed that the postal authorities have a record of the addresses of persons who have moved, or are absent from their customary abodes. The company is always liable for delivery to a person other than the one intended. But it is not liable, if delivery be made to an impostor, if the sender was ignorant of the imposture, and in his ignorance intended the message for him. A curious case illustrative of this arose in Alabama. X telegraphed to A's uncle in A's name, asking for a telegraphic money order. The unsuspecting uncle telegraphed the order, addressed to A, at the place whence X had telegraphed, which was not A's habitual dwelling place. X received the message, and obtained the money. The uncle, on discovering the imposture, sought to hold the telegraph company, on the ground of delivery to the wrong person. But the court held that the delivery was good. At the first blush this appears to be an extreme case, but on more consideration it will be found the right view. Suppose, for example, that the uncle had detected the fraud and had sent the order asked for as a decoy to entrap X, and that the company's agents also knowing the truth, but ignorant that the sender had discovered it, assumed not to deliver the message, or had delayed delivery in order to communicate with the sender. However praiseworthy the motive, this action might undoubtedly be treated by the sender as a breach of contract. It was a delivery to the person whom both parties to the contract intended should receive it ; and in this view the contract was, of course, performed and the company thereby exonerated.

6. The question has arisen whether a telegraph company, as a condition of sending a message which on its face requires an answer, can demand a deposit by the sender as security for the service to be performed in transmitting the reply. The Western Union company has such a rule provided by its by-laws, and under this rule a curious case was recently determined in the state of Indiana. A transient person presented a despatch at the transmitting office, which, in terms, requested an answer; and the operator having refused to place it on the wires, unless a deposit was made to cover the charge for an answer of ten words, an action was brought in which the validity of the rule was considered. The argument of the sender was, that he only invited the company to send his own message; that his request for an answer was a request for the performance of services by his correspondent, and not by the company; and that accordingly the demand for a deposit was wholly without legal warrant. The company, however, successfully contended that it was unreasonable to assume that the sender would ask his correspondent to furnish the information desired, and also to bear the expense of its transmission; and that as there was in effect, a request for the company to perform a further service, the rule requiring a deposit to cover such service was reasonable and valid. The court in delivering judgment said : "We are unable to perceive anything unreasonable in the by-law under consideration. A person who sends another a message, and asks an answer, promises, by fair and just implication, to pay for transmitting the answer. It is fairly inferable that the sender who asks an answer to his message, will not impose upon the person from whom he requests the answer, the burden of paying the expense of its transmission. The telegraph company has a right to proceed upon this natural inference, and to take reasonable measures for securing legal compensation for its services. It is not unreasonable, unnatural, or oppressive, for the telegraph company to take fair measures to secure payment for services rendered; and in requiring a transient person to deposit the amount legally chargeable for an ordinary message, it does no more than take reasonable measures for transmitting the asked and expected message. We have found no case exactly in point, but we have found many analogous cases, which in principle sustain the by-law before us." And so it was upheld.

ELECTRICAL ENGINEERING.[1]

A LAMENT FOR THE ELECTRICIAN.

The profession of "electrician" is fast assuming the unfortunate garb of too many of our trades and professions. It is already, like these, filling the advertising columns of not only its own scientific journals with situations and appointments wanted, but has found a level amongst the clerks and commercial agents seeking any suitable employment rather than find themselves without home or food. What a dreadful come down, indeed ! A profession ranking side by side and carrying the same importance as that of the civil engineer; a profession requiring a wide and varied scientific knowledge, coupled with a mathematical and inventive brain-power; a profession considered perfectly suitable, and, indeed, studied by gentlemen of birth and education, to have reached such a depressed state that even those who have made its mysteries a life-long study, and taken pleasure in doing their best to advance its infant steps to strides of magnitude, now find their hopes crushed, their energies all but wasted, their livelihood quickly disappearing, and their repeated appeals for electrical appointments utterly disregarded. This not only applies to the junior members of the profession, but it is within our knowledge that men ripe in the theoretical truths of this natural, but seemingly unnatural, agent, and experienced beyond a doubt in its practical applications, past holders of important and responsible posts, are at this moment seeking work to do. Their hands, in the past used to the manipulation of telegraph instruments and other electrical apparatus, are now forcibly obliged to be idle, whilst their ready money is expended in repeatedly advertising their talents and consequent requirements. These advertisements appear and reappear, first in one journal then in another, and latterly it has been literally grieving to see that the daily advertising media have received a share of this unfortunate patronage. Unmistakeably the profession has received a terrible blow, a disaster has befallen it so damaging to its young life that it now practically walks on crutches. Such a fate spreads trouble broadcast, as during the last five years the electrical profession has gained such vast importance that the time has been also prolific in the manufacture of students and practical men. These men, as electrical engineers, have found, and still find, their time fully occupied, as they can never finish or neglect to apply themselves constantly to its studies. The scope of these studies involves most engineering subjects, widening almost daily by the importation of new theories and the ever increasing inventions for its practical applications; indeed, electricians find it impossible to be all-round men, or profess proficiency in every branch, as its thousand and one commercial industries are beyond an individual brain. Employment, time, and experience may presently prove merciful enough to attain such an enviable consummation, but specialists are now the order of the day—specialists for special branches, to the lock-out of intruders. Telegraphy and its partisans can swim along easily and successfully because of its riper years, but the newly-initiated electric light and telephony are suffering much. The telephone is chained hand and foot and hampered against competitive improvement by the iron hand of monopoly; whilst electric lighting has been nipped in its budding life and its earlier successes completely smothered by the overwhelming selfishness of a few untutored adventurers, who sought to, and did, enrich themselves at the

1. The *Electrician* (London).

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expense of the most brilliant of domestic commodities. Necessarily its votaries are the immediate sufferers; its admirers have undoubtedly suffered by loss of money, and the general public are suffering from their general mistake. There are some engineering electricians whose pecuniary means enable them to defy commercial depression, and there are even those amongst them, unfortunately, who at this moment actually gloat over the loaded neck of the half-drowned industry, because it gives them time to advance their particular branch by strides, and to insure, perhaps, a monopoly in the future, or to raise their chances in the electrical resurrection. These find enough work, in the absence of competition, to keep them going at a fairly brisk rate. Not so the less favored; they may starve or betake themselves into the whirling lottery for other employment. Now, what is the cause of this state of things? What circumstance is it that within this short space of time has so completely overturned the brilliant prospects of a superior profession, and been the means of beggaring many and stultifying others? The answer is—legislation and speculation.........English commerce and competition are ever on the increase; continually some new theoretical problem is being thrashed into workable condition, and mental activity giving birth to new scientific applications. But in electric lighting is found a commodity which, having reached a certain political point, received a stunning blow, the effects of which will require time and patience to overcome. Some years since American industry lent its fascinating charms to simplify and overcome the difficulties experienced in this country in the manufacture of machinery necessary for the production of the electric current, and also the means for utilizing its energy. Other countries also brought assistance, until our English market was enabled to offer a fairly good assortment of dynamo machines, lamps, and apparatus, intended to revolutionize the existing lighting system, with which people had been familiar for the last 50 years. Necessarily a commotion followed. The public mind became a whirlpool, and excitement increased step by step with the advancing strides of this giant illuminating competitor. Gas shares and dividends were scrutinized, whilst its manufacture became a question of general interest for improvement. It was at this time that gentlemen's sons, finding an occupation opening to them compatible with their social standing, and embodying a professional career, sought eagerly for centres of instruction, and paid heavily in order to be first in the field. Several enterprising capitalists immediately lent themselves and their money to this evident source of profit, with the result that more would-be electricians were turned out than were even then necessary. A few *bonâ fide* corporations were hard at work doing their best to render the new scientific industry a commercial success, and employing both time and money in research simultaneously with active work. As the public confidence was yet wanting, few installations were made, and these few were individual and isolated, for the simple reason that customers could only be found amongst large consumers of gas, and whose calculations taught them that a saving might be effected by the employment of a larger illuminating agent. The manufacturing districts of the midland and northern counties afforded the largest sphere for the efforts of the electrical engineer. Sheffield, for instance, at that time could boast of the greatest use of the electric light. Its enormous iron and kindred works were enabled to continue their work both by day and night; but here it is only fair to say that the commercial value of electrical apparatus was anything but perfect, and consequently its employment in these particular cases was a continual source of professional anxiety. Trained electricians were attached to these individual installations, and, as a matter of fact, found themselves well occupied in constantly adjusting some provoking portion of the circuit whose performances popped here and popped there like the caperings of a jack-in-the-box. The energies, and temper, perhaps, of the electrician might well find cause for compulsory rest after a long spell of such care and anxiety daily, from perhaps four o'clock in the afternoon until eight o'clock the next morning, during the coldest of winter months, continually watching that no failure placed works and workmen in darkness and danger. Such, indeed, has been experienced, and even a ladder kept ready at any moment to mount and arrange refractory carbons or sticking cut-outs.

With an extraordinary commercial foresight and adaptability, one or two particular companies, obtaining patent rights, and representing the manufacture of a specific system, hurriedly obtained quotations for their shares upon the stock exchange, and surprised both the electrical and commercial world by their sudden activity in preaching the surprising merits of their own wares. Enterprise and duplicity were not wanting. No trouble was spared to excite the public mind to a state of frenzy, and undoubtedly such efforts were rewarded, much to the detriment of both people and enterprise. Undoubtedly the public were duped, whilst those behind the scenes, the instigators of so foul a bubble, laughed in their sleeves. Company shares were run up and concessions sold to subsidiary companies, whilst promoters quietly and greedily pocketed a first-rate income. One or two, personally known, could pocket their thousands in a week. The stock-brokers were exceedingly busy, shares continually changed hands, money was lost and money made, until the speculative epidemic seemed to have laid a siege and so bombarded the excitable commercial susceptibilities of the business man that no room was left to listen to the warning voice of the reasoning electrician, who foresaw the imminent evils of such precipitate action. The sequel followed, a review of which commenced with the subsidiary companies being thrown for the first time upon their own resources. To find legs wherewith to stand appeared to be a matter of great difficulty to not a few of them after the vast expenditure entailed in the purchase of the right and its conveyance. Starting with brilliant hopes, excited determination did much to render those in office obdurate to the difficulties before them. Such matters had not been considered, and there was not time now to look at the stern matter-of-fact duties that lay before. In some cases a large amount of capital was spent in building central stations with the idea of supplying householders with domestic electric lighting from the one centre, and upon the same mains as the public lighting of the streets, whilst others wasted their substance in some other imprudent or riotous commencement to their existence. It must have come upon them as a depressing fact that, coincident with their finding out the many difficulties with which they had to contend, arising partly from the incomplete condition and unsuitability of their electrical apparatus, and the want of money, the public enthusiasm seemed to be abating, that the quotation of shares was gradually ebbing out its life, and that the great speculation agitators, finding their game played out, were taking back places and otherwise finding refuge in obscurity. Then, and not till then, came upon these subsidiary companies the realization of their position; foundations built on the sand, with not even a pecuniary backbone as a prop; public enthusiasm dead; scientifically insufficient and inefficient tools to work with; a one-sided and unworkable act of parliament of rights and restrictions, and no money; a chaos of disasters, being a death blow to any enterprise whatsoever. Failure followed, and, one by one, each found its way into the list of voluntary or compulsory liquidations; and, as a calm always succeeds a storm, so a terrible period of inactivity in the electric lighting commercial industry has proved no exception to the rule. For the last two years the majority of electricians have found their services immensely at a discount, and many have even had difficulty to subsist. Of the public installations, which had been almost considered as permanencies, some have died, and others are gradually disappearing. Even the Thames embankment falls back

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upon its old friend and faithful servant, whilst the city lighting has resolved itself into a few straggling and struggling old type, perhaps half-discarded, Brush lamps. Into what a state of collapse has it descended! Into a bottomless pit? Well, hardly as far as that. Resuscitation has yet a chance, and will step in; but when? is the question.

MINIMUM E. M. F. IN TRANSMITTING POWER.

BY PROFESSOR H. S CARHART.

THE prominence attained by recent practical experiments in the electrical transport of power justifies the fullest theoretical discussion. Any light that theory can throw upon the subject must be of some value. I shall therefore attempt to make clear the question of minimum E. M. F. that can be employed under defined conditions, even at the risk of being too mathematical for some readers.

So far as observed the discussions of the general problem have proceeded upon the following basis: Given the E. M. F. of the generator and the resistance in circuit, to find the *maximum* rate of working, or the maximum work that the motor can do. What I propose is, given the resistance in circuit and the work required of the motor, to find the *minimum* E. M. F. This latter is the form in which the matter presents itself as a practical problem. I shall first give the usual solutions corresponding to the former conditions, and then the new solutions with the latter defined ones. In each case R and C denote resistance and current strength, E and E_1 the direct and counter E. M. F. of generator and motor respectively, and W the work done by the motor per second.

First. Given E and R to find C and *maximum* W.

a. Algebraic solution. The total energy of the current is divided into two parts, one of which goes to heat the conductor, and the other is absorbed by the motor and converted into useful work. Hence

$$C E = C^2 R + W \qquad (1)$$

The solution of this equation of the second degree is

$$C = \frac{E \times \sqrt{E^2 - 4 R W}}{2 R}$$

Plainly $4 R W$ cannot exceed E^2, or C would have an "imaginary" value, which is impossible. W will therefore be a maximum when $4 R W = E^2$. Hence,

$$W = \frac{E^2}{4 R} \text{ and } C = \frac{1}{2} \frac{E}{R}$$

The current for maximum work is therefore reduced to half the value it would have with the motor at rest, and $E_1 = \frac{1}{2} E$. This is known as Jacobi's law. It is not the law of efficiency but of maximum activity.

In the above values W and C are expressed in given terms; and we have the further deduction that for maximum rate of working the counter E. M. F., of the motor equals half the direct E. M. F. of the generator.

b. Solution by the calculus. By transposition of (1)

$$W = C E - C^2 R \qquad (2)$$

Whence $\frac{d W}{d C} = E - 2 C R = 0$ for the *maximum* value of W, since the second differential is negative. Therefore

$$E = 2 C R \text{ and } C = \frac{1}{2} \frac{E}{R} \text{ as before.}$$

The value of W may be found by substituting the value of C in (2).

Second. Given W and R to find C and *minimum* E.

a. Algebraic solution. The work done by the motor is

$$C E_1 = \frac{E_1 (E - E_1)}{R} = W \qquad (3)$$

If W and R are constants then is $E_1 (E - E_1)$ a constant also. Now when the product of two terms is a constant their sum is a minimum when they are equal to each other. But the sum of E_1 and $E - E_1$ is E, the E. M. F. of the generator. Hence E is a minimum when E_1 equals $E - E_1$, or $E_1 = \frac{1}{2} E$. This condition corresponds to Jacobi's law as might have been inferred directly, because the conditions determining maximum rate of working with a given E. M. F. must also define the minimum E. M. F. required to do a given amount of work.

To determine E and C in terms of W and R, substitute for E_1 in (3) its value $\frac{1}{2} E$, and we have

$$E^2 = 4 R W, \text{ or } E = 2 \sqrt{R W}.$$

$$\text{Whence } C = \frac{1}{2} \frac{E}{R} = \sqrt{\frac{R W}{R^2}} = \sqrt{\frac{W}{R}}$$

b. Solution by the calculus. From equation (1)

$$E = C R + \frac{W}{C} \qquad (4)$$

Whence $\frac{d E}{d C} = R - \frac{W}{C^2} = 0$ for *minimum* value of E, since in this case the second differential coefficient is positive. Hence

$$R = \frac{W}{C^2} \text{ and } C = \sqrt{\frac{W}{R}} \text{ as before.}$$

Substituting value of C in (4) and

$$E = 2 \sqrt{R W}$$

$$\text{Also } C E_1 = W \therefore E_1 = \frac{W}{C} = \sqrt{R W}$$

Therefore $E_1 = \frac{1}{2} E$ as above.

It appears, therefore, that the E. M. F. varies as the square root of the resistance. Hence, if any reduction of E. M. F. is attempted by reducing the resistance, the reduction of the latter must be much more rapid than the former. If R is reduced to one-fourth, the E. M. F. is reduced only to one-half. But the resistance may be increased fourfold by merely doubling the E. M. F., the same amount of work being done with the same efficiency. Whenever attempts are made to work with low E. M. F., as considerations of safety demand, then difficulties at once present themselves. The above discussion shows that with the requirement of a given amount of work to be done by the motor, the E. M. F. has a minimum value which cannot be reduced except by an inordinate and impracticable reduction of resistance.

To apply the results to a concrete example. Assume twenty locomotives on a New York elevated road to represent 2,200 h. p. If the electric motors replacing them have an intrinsic efficiency of 90 per cent., in round numbers 1,800,000 watts of energy must be supplied to the motors per second. If the resistance in circuit is 0.072 ohm, then

$$E = 2 \sqrt{R W} = 2 \sqrt{1{,}800{,}000 \times 0.072} = 720$$

$$\text{and } C = \frac{W}{R} = 5{,}000$$

With an assumed resistance of about three-quarters of an ohm the minimum E. M. F. required to transmit to the motors 2,200 h. p. is 720 volts, and the current is 5,000 ampères.

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COMPETITIVE TESTS OF DYNAMO ELECTRIC MACHINES.

REPORT OF THE FRANKLIN INSTITUTE COMMITTEE.

To the Board of Managers of the Franklin Institute:

GENTLEMEN :—I herewith transmit the report of the Committee of Judges, consisting of Louis Duncan, Ph.D., Ensign, U. S. Navy, Chairman ; William D. Marks, Whitney Professor of Dynamic Engineering, University of Pennsylvania ; George L. Anderson, Lieut. U. S. Army, Instructor of Mathematics, U. S. Military Academy, West Point ; J. B. Murdock, Lieut. U. S. Navy ; A. B. Wyckoff, Lieut. U. S. Navy, Hydrographic Office, Philadelphia, appointed under authority of the resolution of the Board, adopted November 12, 1884, to conduct competitive tests of dynamo-electric machines, entered for competition by the Edison Electric Light Co., and the United States Electric Light Co., who duly accepted them as judges.

It was found impossible to constitute the committee from the list of names in the adopted code, most of those gentlemen declining to serve, or accepting under unavailable conditions.

Commander Jewell, U. S. Navy, acted as chairman at the beginning, and rendered valuable assistance and advice in the preliminary preparations. Owing to unavoidable delays, however, the tests were not begun before his paramount duties at the U. S. Torpedo Station compelled him to withdraw.

The conditions of the code were severe upon the judges, requiring protracted runs of the machines, and immediate calculations of results. The labors of the committee were therefore incessant, and were performed with such zeal, intelligence, fidelity, and success as to satisfy me that no praise of mine could exceed that to which a careful examination of the report of their work will entitle them.

The thanks of the Institute are due not only to the judges, but also to the heads of the departments and bureaus of the navy and army, whose consent was necessary to enable the officers to take part in the work.

The Institute is under especial obligations to the Johns Hopkins University for the use of their laboratory and for assistance in comparing thermometers and resistances.

The thanks of the Institute are also due to various parties for loans of apparatus, as follows :

Baldwin Locomotive Works, for use of boiler ; Buckeye Engine Co., Salem, O., for steam engine ; Professors Genth and Sadtler and the department of dynamics of the University of Pennsylvania, for platinum crucible, indicators, resistance coils and galvanometer ; U. S. Coast and Geodetic Survey, for magnetometer ; Stevens Institute of Technology for tangent galvanometer ; Mr. Wm. Harpur, for chronometer ; Mr. Henry Trœmner, for delicate balances ; Messrs. Fairbanks & Co., for beam, platform scales and standard weights ; Electrical Supply Co., of New York, for voltameter ; Commander Jewell, U. S. Navy, and the members of the committee, for the use of their instruments.

Very respectfully,

W. P. TATHAM, *President.*

PHILADELPHIA, September 26, 1885.

RESOLUTION.

[*Resolutions of the Board of Managers*, Nov. 22, 1884.]

WHEREAS, Through delay and lack of time on the part of many of the examiners, several of the largest exhibits at the Electrical Exhibition have had either incomplete examination or have had none at all ; therefore, be it

Resolved, That the president be directed to take such steps, appoint such committees, and incur such expense, not exceeding three thousand dollars, as shall be necessary to complete in a satisfactory manner the examination of exhibits.

MR. W. P. TATHAM, *President of the Franklin Institute:*

SIR :—I have the honor to herewith transmit the report of the committee appointed to conduct the competitive tests of the dynamo-electric machines of the U. S. Electric Light and Edison companies.

I am, very respectfully yours,

LOUIS DUNCAN, *Chairman.*

COMPETITIVE TESTS OF DYNAMO MACHINES.

On first organizing the committee, Commander Jewell, U. S. N., was elected chairman, but after directing some of the preliminaries, he was compelled to resign in order to resume his duties at the U. S. Torpedo Station, at Newport.

The tests were conducted under the following code, agreed to by the contestants :

Proposed Code for Test of Dynamo-Electric Machines to be used by the Franklin Institute of the State of Pennsylvania.

SECTION I.

GENERAL CLAUSES AND CONDITIONS.

(1.) The parties hereto subscribing do agree to accept the services of the examiners herein named, and to abide by the verdict of the judges and the methods of testing named without appeal from the decision reached.

LIST OF JUDGES.

(*From which five shall be chosen to act.*)

(2.) Prof. WM. A. ANTHONY, Cornell University, Ithaca, N. Y.
Prof. WM. D. MARKS, University of Pennsylvania, Phila., Pa.
Prof. J. E. DENTON, Stevens Institute, Hoboken, N. J.
Prof. W. E. GEYER, Stevens Institute, Hoboken, N. J.
Lieut. J. B. MURDOCK, U. S. N., Philadelphia, Pa.
Ensign LOUIS DUNCAN, U. S. N., Johns Hopkins University.
Lieut. JOHN MILLISS, Light-House Board, New York.
OSCAR BUSSMANN, Assistant.

(3.) The Franklin Institute will procure instruments, pay expenses of observers. The companies will pay for handling machines, running lines, placing and erecting lamps, and care for machines during test.

SECTION II.

CONSTRUCTION OF THE MACHINE.

(4.) The following data will also be given :
- Diameter of armature ;
- Weight of machine ;
- Number of commutator bars ;
- Turns and length of wire in armature coils ;
- Whether brushes must be adjusted, or are automatic for different currents ;
- Diameter and length of bearings ;
- Number of turns per minute ;
- Number of volts for best work ;
- Number of ampères for best work.

SECTION III.

PRELIMINARY TESTS.

(5.) The resistance of the field magnet coils and of the armature coils will be measured as follows : A strong current from a secondary battery shall be passed through these coils and ampère-meter and sensitive voltameter used to determine current and fall of potential. The resistance will be determined from these measurements. As an additional precaution, a strip of german silver of known resistance shall have its fall of potential measured with the same current and instruments. These measurements shall be made before and after the tests, with the machine hot and cold.

INSULATION RESISTANCE.

(6.) Tests will be made of the insulation of the terminals of the machine from its metal bed-plate.

Tests will be made of the insulation resistance between the commutator and the axle.

(7.) It is understood between the parties that if any mechanical defect is observed, another machine may be substituted if the committee agree that such defect exists.

The competitors shall have reasonable opportunity to obtain information of the progress of the tests, and to know the figures of each test for the object of ascertaining errors in time for correction.

The observations made will be publicly posted before the machine is removed from the dynamometer.

CALIBRATION OF INSTRUMENTS.

(8.) The constants of all instruments used shall be determined by at least two independent methods. The companies shall have opportunity to inspect and observe the methods used and shall be furnished with the constants of the instruments immediately after they have been determined. All objections to the methods used

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will be received and acted upon as provided under Section IV., Article 17.

SECTION IV.

QUANTITATIVE TESTS.

(9.) The dynamo to be tested will be run under full load for ten hours continuously, to see that all is in good working order before the tests begin.

(10.) For the actual test the machine shall be run and the temperatures of the pole pieces and armatures observed until a uniform temperature is reached.

(11.) When a uniform temperature for each load is reached, the measurements of power shall begin.

(12.) The machine will be tested on both live and dead resistances.

(13.) The machine will be tested on one-quarter, one-half, three-fourths, and full load. In the latter case to be run at least five hours after a uniform temperature is reached.

(14.) Full measurements of friction and of energy expended in field will be made in each case.

DYNAMOMETRIC MEASUREMENTS.

(15.) The shaft of the dynamo will be directly attached to the end of the shaft of Tatham's dynamometer, by means of a universal joint coupling, and the horse-power used read from the dynamometer, unless the committee, for reason, shall decide otherwise.

OBSERVATIONS.

(16.) The observations on the dynamometer, current galvanometer, and potential galvanometer, and all other instruments, will be taken at synchronous intervals.

The temperature of the room will be made as even as possible, and the temperature noted and necessary corrections made.

The adjustment and oiling of machines shall be in the hands of the authorized expert for the company.

(17.) In case any objection be made, or difference of opinion should arise between the committee and the contestants, the unanimous vote of the committee shall be final.

If, however, there be not a unanimous vote, the minority of the committee shall appoint one referee and the majority another, these two shall appoint a third referee.

The decision of the majority of these referees shall be final.

In all determinations of efficiency of machines, measurement of potential shall be made (simultaneously with measurements of the current strength) at the binding posts of the machine, and at such other points of the circuit as will determine the total fall of potential, due to the resistance of the leads, connections and switches included in circuit with the instruments used for determining current strength. From these measurements, the loss shall be calculated and credited to the machine under trial.

[Signed] FRANCIS R. UPTON.
United States Electric Lighting Company per EDWARD WESTON, *Electrician.*

Figure 1 gives the general arrangement of the apparatus. The test room, in which most of the instruments for electrical measurement were placed, was in about the middle of the exhibition building of the Franklin Institute. The dynamos, with the boiler and engine used in running them, were in a shed at one corner of the building; and the resistances for their external circuit—lamps and german silver strips—in a room inside the building and very near the shed.

The storage battery, tangent galvanometer for current calibrations, and galvanometer for measuring field currents, were in different parts of the building, far enough from the test room not to affect the instruments in it.

The leads from the dynamos and storage battery, and to the tangent galvanometer were of heavy, insulated copper cable. They were taken to the corner of the test house farthest from the instruments, and where they approached it the two parts of a circuit were twisted together, one of them being covered with rubber tubing as an additional precaution against leakage. Even with the heaviest currents (about 400 ampères) there was no effect on the instruments, and calibrations made both when the dynamos were and were not running, showed that any disturbance from currents in the leads had been avoided.

Before any measurements were made, the insulation resistances between the leads themselves, and from the leads to the ground, were carefully tested and found in every case to be over 50 megohms; and measurements at intervals during the tests showed that they remained about the same.

OBSERVATIONS.

The power applied to the dynamos was measured by a Tatham dynamometer, while the electrical energy was calculated from observations of the potential at the terminals of the machine, the currents in the external circuit and field, and the resistance of the armature. The latter was measured by sending a current from a storage battery through the armature and observing the current in the circuit and fall of potential between the terminals of the machine.

The dynamos were run both on lamps and dead resistance, the value of the latter serving as a rough check on the potential and current.

APPARATUS.

Storage Battery.—This was kindly furnished by Mr. Weston, and was used for all calibrations, measurements of armature resistance, etc. Seventeen cells in series were generally employed; they were placed on boards separated from the floor by porcelain insulators.

Tangent Galvanometer.—This was used for calibrating the current galvanometer. It consisted of a single turn of large sized wire fastened on the edge of a wooden disc which was nailed against a square board frame. The ends of the wire were bent up parallel to each other and fastened by brass connectors to the leads. A correction due to the space between the ends of the turn was applied to the mean radius.

The diameter, about two metres, was measured in different directions, and the mean taken in calculating the constant.

There was a space cut in the middle of the wooden frame, with a shelf for the compass and needle. After the needle was adjusted to the centre and leveled, plumb lines and pointers were arranged so that any warping or change of level could be at once detected.

The value of H was determined by a magnetometer of the coast survey pattern with detached theodolite; it was found to be

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and the constant of the galvanometer;

31.088 ampères.

External Resistances of Dynamos.—The "dead" resistances for the external circuit of the dynamos were made of german silver strips 1¼ inches wide by about .01 inch thick. They were eight in number, each wound on a frame about 3 feet square by 10 feet high, made of four wooden uprights with pieces framed across at the top and bottom. Porcelain insulators were fastened horizontally to the cross pieces and the resistances passed under one of the bottom insulators, over one at the top, to the bottom again, etc. Heavy copper wires were hard soldered to the ends of the strips and taken to the switch board.

The resistances were adjusted by cutting out part of the strip by a short length of german silver with clamps at the ends, which could be shifted to cut out as many of the turns as was desired. The coils were adjusted by means of a calibrated bridge, to 2.400 ohms at 20° C. There was a good air circulation in the room and 50 ampères could be carried by each coil.

In the same room with the german silver resistances were the racks for the incandescent lamps used for "live" resistances.

Switch Board.—Two troughs about 2½ feet long and 1½ inches wide, and 10 inches apart, were cut in a heavy block of wood. Between them were bored two rows of eight holes each, and into these were fitted glass insulators turned upside down to serve as mercury cups. The wood was soaked in boiling paraffine, and melted paraffine poured between the cups and allowed to harden. The distance between the troughs and the middle of the nearest row of cups was three and a half inches; between the two rows,

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and the cups in each row, three inches. The cups and troughs were filled with mercury, heavy amalgamated copper rods in the latter serving to increase the conductivity. The resistances were brought to opposite cups in the two rows.

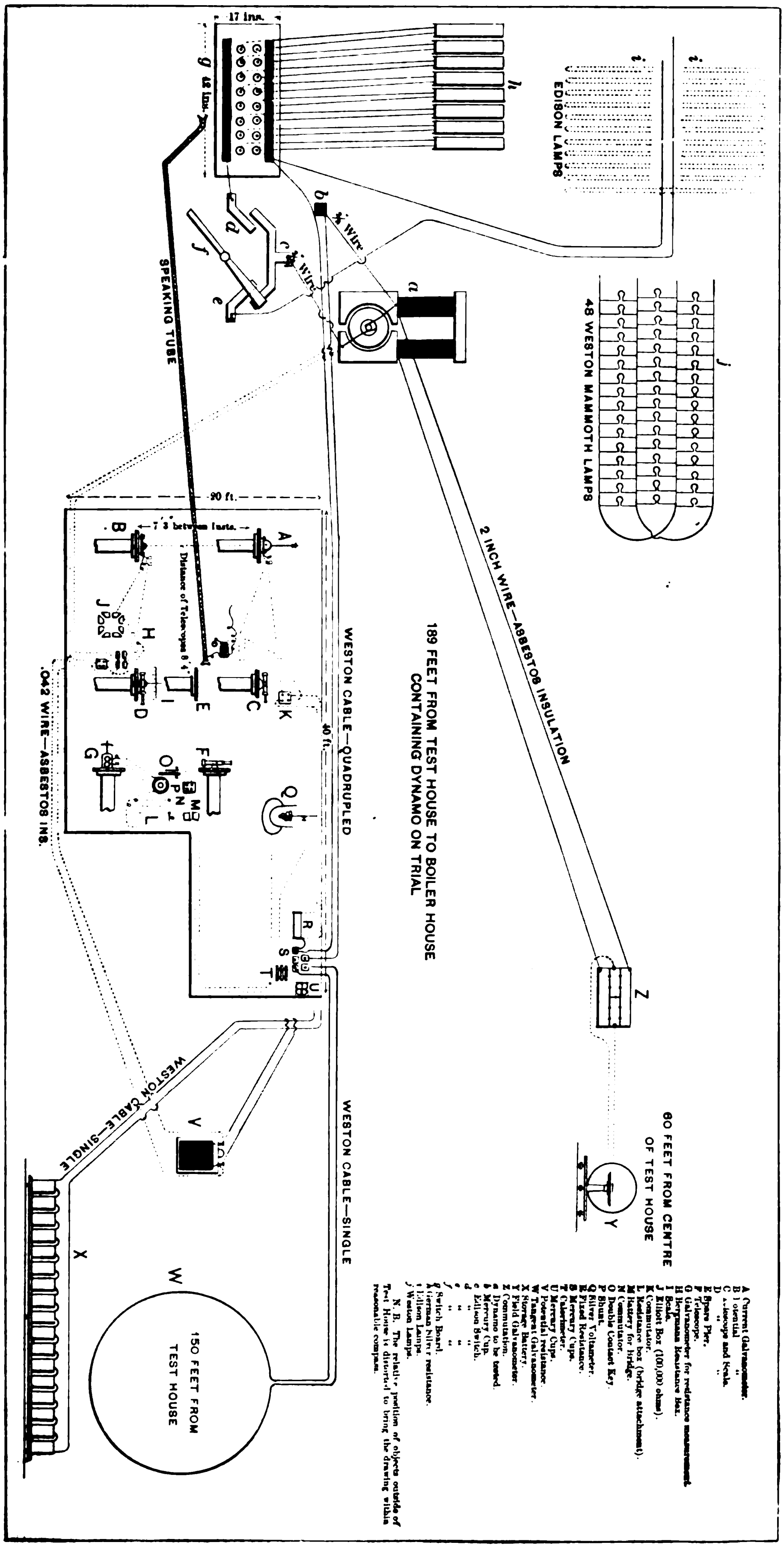

FIGURE 1.—ARRANGEMENT OF TESTING APPARATUS.

The dynamo circuit was from one terminal of the machine to an ordinary Edison switch, by which the current could be made or broken, to one of the troughs; through the resistance to the other trough; to the test house, passing through the fixed resistance for current measurement there; back by the other lead to the dynamo.

Connections at the switch board were made by thick U-shaped copper rods, with a stretch of three and one-half inches. The resistances could be readily arranged in any desired way, with little or no chance of causing accident by making mistakes. The insulation between the troughs and the cups and the troughs themselves was practically perfect.

Field Galvanometer.—The current in the field of the dynamos was measured by a tangent galvanometer of the Helmholtz type, the coils being each a single turn of large sized wire. It was calibrated at the same time as the current galvanometer, being reversed as often as possible, and the same end of the needle read on each side of the zero mark.

Wheatstone Bridge.—For measuring resistances that could not be taken to the Johns Hopkins University, a resistance box, with a bridge attachment by Elliott, of London, was used, with a Thomson astatic mirror galvanometer. The box was standardized, as described below.

Calorimeter.—The calorimeter is shown in figures 2 and 3.

This was used for calibrating both the potential and current galvanometers; it was made of copper, was cylindrical in shape, about eight inches in diameter by ten inches in height, and held about 18 pounds of water.

The cover was screwed to a flange on the cylinder, the joint being water-tight; in it were holes with raised flanges around them, for the terminals of the coil and the thermometer. For stirring, a shaft, working in a bearing on the bottom of the cylinder and passing through the cover, had on it five paddles arranged along its length and at different angles around it, and bent to throw the water past the wire out to the side of the vessel. On reaching the side, a downward motion was given to it by strips of light copper, making an angle of about 30° with the vertical, soldered to the cylinder and projecting inward one and one-fourth inches. On the bottom of the shaft was a propeller blade. Putting saw-dust on the water and turning the shaft slowly showed the circulation to be excellent. Turning the wheel belted to the pulley on the shaft three times per second, raised

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the temperature of the calorimeter .02° C. in five minutes. In the later experiments it was only turned once per second, so the error from this correction must have been small.

In the first three experiments, copper wire of about 1.3 ohms resistance was used ; in the last two, platinum-silver wire of 1.1 ohms. The coil was held in the cylinder as follows : At equal distances around the cylinder, at the top and bottom, were soldered pieces of copper projecting inward, with clamps at their ends. The wire was wound on glass rods held in a light frame work ; the whole was placed in the cylinder, the rods clamped in place and the framework cut away, leaving a clear space for the stirring arrangement.

The terminals were small copper cups, thoroughly amalgamated and partly filled with mercury. They were surrounded by a rim of ebonite and wedged in their places in the cover.

The calorimeter fitted in a light iron frame, from which it was separated by small blocks of ebonite. The whole

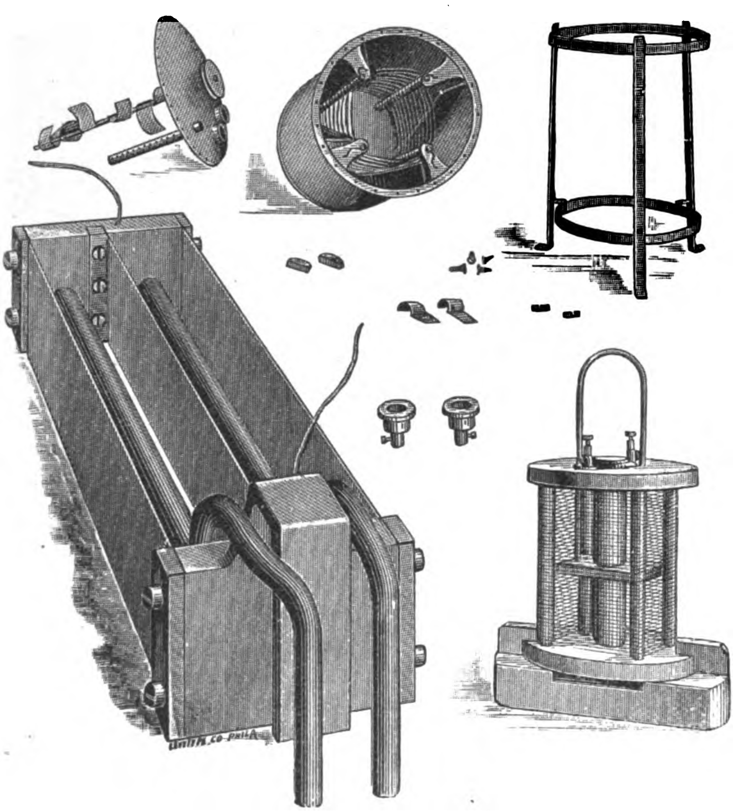

FIG. 2.—Calorimeter, Fixed Resistance and Potential Resistance.

was surrounded by a tin cylinder fitting closely on the shelf to which the frame was fastened, so there was no draught past the cylinder.

Balances.—Two balances were used, one for weighing the calorimeter, the other in voltameter work. The former could weigh up to 30 pounds and was very sensitive. The latter was an excellent analytical balance. Both were by Trœmner, of Philadelphia, and the weights were compared with standards in his possession.

Thermometers.—The thermometers generally used were by Green, of New York. They were divided into degrees and tenths, and were compared at the Johns Hopkins University with one of the standards there, the apparatus used in the comparison being that described by Professor Rowland, in his "Determination of the Mechanical Equivalent of Heat."[1] For the last two calorimeter experiments, a thermometer by Hicks, of London, was used. It was graduated to centimetres and millimetres, and was one of those used by Mr. Leibig, in his work "On the Variation of the Specific Heat of Water."[2]

Potential and Current Galvanometers.—These will be described under measurements of potential and current. They, with the other instruments in the test house, rested on stone slabs cemented on the top of heavy wooden posts, sunk about two and one-half feet in the ground.

MEASUREMENT OF RESISTANCE.

For the standard resistance, a ten B. A. unit coil by Elliott, which had been compared at the Cavendish laboratory, and was used by Professor Rowland in his recent determination of the ohm, was employed. The values of the resistances in terms of this coil were reduced to the Paris ohm, by dividing by

1.0112

The bridge used in the comparisons was built at the University workshops, Cambridge, England. Its fixed (equal) arms were connected by a platinum-silver wire bent in a circle, and their ratio changed by making contact with the galvanometer circuit at different points on the wire. Beside the wire was a scale, and on the arm carrying the galvanometer contact, a vernier reading to tenths of a division. When the fixed coils were each one ohm, a whole division of the scale meant a change of one part in 10,000 of the ratio, while with the galvanometer used, a change of one-tenth of a division, or one part in 100,000 could be detected. The bridge had been calibrated for use in the determination of the ohm. With fixed coils of one ohm, the range of the instrument was about ten per cent., so the resistances to be compared were always approximately equal.

The different coils to be compared were balanced against resistances taken from "comparators," designed by Prof. Rowland. Each of these consists of ten coils of equal resistance wound together on a copper cylinder, the whole being coated with wax or paraffine and put inside a larger cylinder, the space between being filled with feathers. At the top, the cylinders are separated by an annular sheet of hard rubber, around which two circles of ten holes each are bored for the terminals. The ends of each coil are taken to copper blocks screwed firmly beneath opposite holes in the two circles. The tops of the copper blocks are thoroughly amalgamated and the holes partly filled with mercury, connections being made by short U-shaped copper rods.

Three comparators of 10, 100 and 1,000 ohms were used, giving a range of from 1 to 10,000 ohms.

Each coil of the 10-ohm comparator was balanced directly against the 10-ohm standard, then the ten coils in series were balanced against each of the 100-ohm coils, and finally the 100-ohm comparator in series compared with each of the 1,000-ohm coils. In the measurements, the inner cylinders of the comparators were filled with water and the standard immersed in water, the temperatures being noted.

The zero of the bridge scale was taken as the mean of the readings when the resistances being measured were reversed.

In measuring the resistance boxes, they were kept for six or eight hours in a room whose temperature was nearly constant, and then balanced against corresponding resistances taken from the comparators, the temperatures being, of course, noted.

The coil for potential measurement was immersed in turpentine, its temperature recorded, and its resistance measured as above.

The resistances compared at the Johns Hopkins University were the box for current measurements, the coils and bridge for measuring resistance, and the coil for potential measurement.

MEASUREMENT OF POTENTIAL.

The galvanometer used for potential measurements was

1. Proceedings of the American Academy of Arts and Science, 1880.

2. *American Journal of Science*, July, 1883.

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by Hartmann. It was furnished with a Siemens' bell magnet, closely surrounded by a solid copper block, and dampened very readily, only making two or three swings before coming to rest. The suspension was a silk fibre about fifteen centimetres long. The coils, specially wound over the regular winding of the instrument, had a resistance of about two ohms.

The galvanometer was in a circuit with resistances that were varied from 1,000 to 150,000 ohms, taken from boxes, two of 100,000, one of 10,000 ohms, the former by Elliott and Breguet, the latter by Bergman. All calibrations being made with the (30,000 + 20,000) Elliott coils in the circuit, it was necessary to compare the other resistances with these coils. The arms of the bridge being made equal, the (30,000 + 20,000) and (40,000 + 10,000) Elliott coils were balanced in succession against the 50,000 Breguet, resistances being added to one or the other until there was no deflection of the galvanometer. It was found that

50,000 Breguet = (30,000 + 20,000 + 280) Elliott.
50,000 Breguet = (40,000 + 10,000 + 250) Elliott.

The (30,000 + 20,000) ohms Elliott was also measured in terms of the bridge coils, and the value found, 49,960, was so nearly correct that in getting the ratios of the 1,000 and 2,000 ohms Bergman—used in measuring armature resistance—to the (30,000 + 20,000) coils, it was assumed that their values in terms of the bridge coils were the same as if measured in terms of the (30,000 + 20,000) ohms.

The deflections were read by a telescope and scale, the latter by Brown and Sharpe, graduated to centimetres and millimetres. The distance from the telescope to the mirror was two and one-half metres.

Calibrations.—The galvanometer was calibrated, both by measuring a current passing through a standard resistance at whose terminal the leads of the instrument were connected; and by the difference of potential at the terminals of a calorimeter. The constant was also checked with that of the current galvanometer, after each test, by measuring the current through the german-silver strips used for the external circuit of the dynamos, and the potential at their extremities.

During the tests, 40 calibrations were made; 36 with the silver voltameter and standard coil, and four with the calorimeter. The constants determined by the calorimeter agreed so closely with the measurements by the voltameter, and the labor both of observation and calculation in the former was so much greater than in the latter, that it was thought unnecessary to make the observation any oftener.

Voltameter Calibrations.—The current used varied from one to one and one-half ampères, giving a difference of potential at the terminals of the standard coils of from 20 to 30 volts. The coil shown in figure 1 was of No. 22 german-silver wire, wound on glass rods fixed in a wooden framework. The turns were kept apart by silk cord wound on the rods. The whole was immersed in a high grade oil (300° fire test) kindly furnished by the Standard Oil Company. The oil was constantly stirred while the current was passing. The measurement of the resistance has been described. Its value was

21.161 ohms, at 14° C.

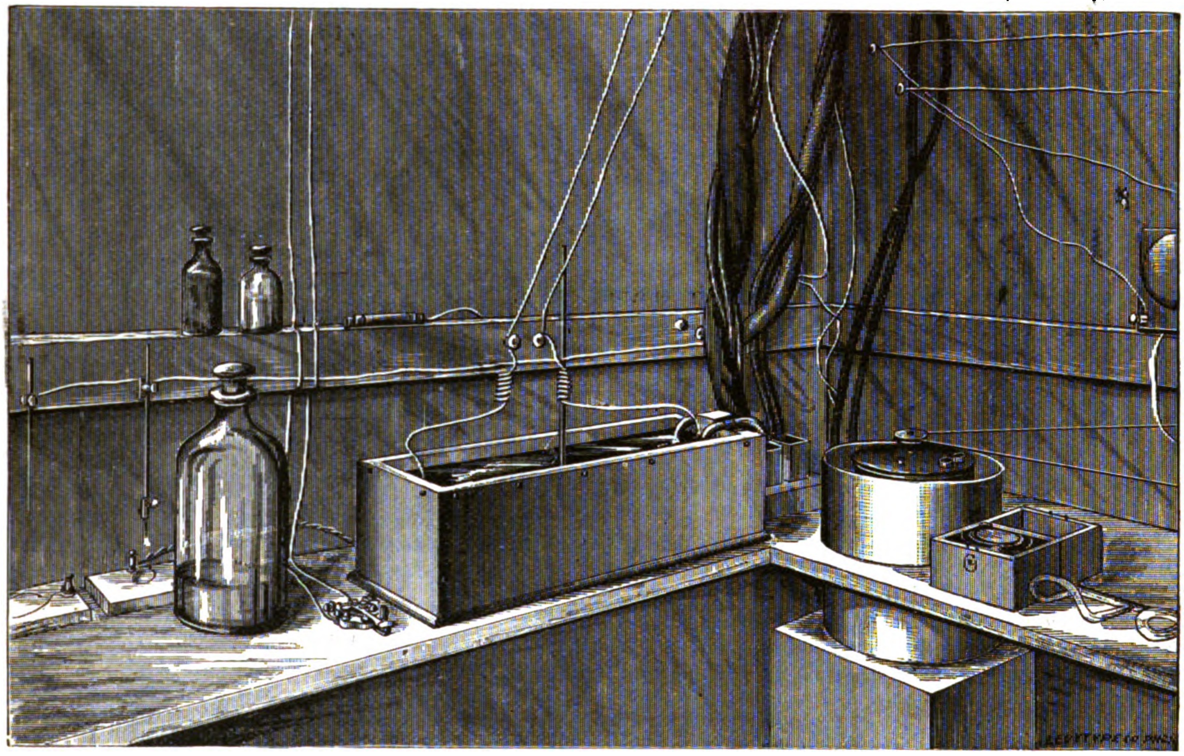

FIGURE 3.—Test Room with Instruments in Position.

For measuring the currents, a silver voltameter was used, the anode being a spiral of silver wire wrapped in filter paper, the cathode a platinum crucible filled with a 40 per cent. solution of silver nitrate. The calibrations took from 10 to 20 minutes, the deposit ranging from .9 gram to 2. grams. The times were noted by a chronometer whose rate, + 1 second per day, was neglected.

When the experiment was finished, the solution was poured out of the crucible; the deposit first washed with distilled water, then allowed to soak from one-half hour to 12 hours, then washed again until there was no precipitate with a solution of sodium chloride, and finally slowly dried and then weighed.

A double reading of the galvanometer was taken each minute, and the constant calculated from the mean reading for the time of observation. The constant is given by

$$k_{50} = \frac{C\,R\,(1 + M_c\,(t_c - 14^\circ))}{2d} \left\{ 1 - M_b\,(t_b - 25^\circ) \right\}$$

where

k_{50} = constant for (30,000 + 20,000) ohms;
R = resistance of standard coil at 14°;
t_c = temperature of standard coil;

M_c temperature coefficient of standard-coil;
M_b = temperature coefficient of box;
t_b = temperature of box;
$2d$ = double deflection of galvanometer;
25° being taken as the standard temperature of the box.

When other resistances were used in the circuit, the constant was multiplied by their ratio to the (30,000 + 20,000) ohms.

Calorimeter Calibrations.—The calorimeter has been described. In making the observations, the time the mercury crossed each half degree or centimetre of the thermometer was taken as the mean of the times of crossing the tenths before and after the division, and the division itself. In calculating the water equivalent of the calorimeter, the weight of the shaft was multiplied by the specific heat of steel; that of the cylinder by the specific heat of copper, and the weight of the glass and wire by their specific heat. For steel, the value of the specific heat was assumed to be

.1110

and that of copper

.0940

The principal correction to be applied is due to radiation. The other corrections are for rise of temperature from stirring, for the part of the thermometer stem in the air, and a small one for weighing in air.

The coefficient of radiation was determined by noting the rate of cooling, the calorimeter being slowly stirred. Experiments gave

Difference between air and calorimeter,	10° C.	coefficient, .00154
" " " " "	5° C.	.00150
" " " " "	0° C.	.00149

Before the experiments, and for the determination of the radiation, the cylinder was carefully polished.

The correction for stirring was determined by bringing the calorimeter to exactly the temperature of the air, and then turning the wheel belted to the pulley on the shaft three times per second. The rise of temperature was .02° in five minutes. For the smaller velocity used in the later experiments, the heating was assumed to vary as the cube of the velocity.

The correction for the temperature of the stem was taken from

$$c = .000156\, n\, (t - t'')$$

The following is one of the calibrations:

Calorimeter Observations. *Observers:* { Anderson. Duncan, June 20th, 11:40 A. M.

Time of passing ½ Centimetre.	Temperature of Calorimeter.	Temperature of Air.	Absolute Temperature of Calorimeter.	Thermometers.
	C. M.			
31-19.8	17.50	27.	24.129	For calorimeter, Hicks No. 108947.
32-35.7	18.	26.9	24.826	For air, Green No.
33-52.3	18.50	26.8	25.523	
35-08.3	19.	26.9	26.221	Water equivalent of calorimeter, corrected for weighing in air
36-23.8	19.50	26.9	26.918	= 8.4311 kilos.
37-41.3	20.	27.0	27.618	
38-56.7	20.50	27.3	28.316	Value of mechanical equivalent used (corrected for Latitude)
40-14.2	21.	27.4	29.015	
41-29.7	21.50	27.6	29.713	= 425.75
42-46.2	22.	27.7	30.411	

Current: Wyckoff, *Observer.* Potential: Murdock, *Observer.*

Deflection.	Remarks.	Deflection.	Remarks.
17.56	$R = 40$	10.27	$R = 50,000$
.56	t_b 23.°	.26	$t_b = 22°$
.53	t_s 22.4°	.26	
.56	t_g 24.°	.26	
.54		.25	
.56		.27	
.54		.26	
.53		.24	
.51		.28	
.48		.26	
.50		.27	
.47		.29	

In making the calculations, Rowland's value of the mechanical equivalent was taken, because the thermometers used in the above experiment were compared directly with those employed by Prof. Rowland, and thus errors in thermometry were to a large extent eliminated. The following are the calculations for the observations:

Interval.	Corresponding Interval in Degrees.	Corresponding Interval of Time.		Degrees per Minute.	Same Corrected for Radiation.
centimetres.		min.	sec.		
17.5 to 20.	3.489	6	21.5	.5488	.5473
18 to 20.5	3.490	6	21.0	.5496	.5490
18.5 to 21.	3.492	6	21.9	.5486	.5487
19 to 21.5	3.492	6	21.5	.5492	.5502
19.5 to 22.	3.493	6	22.5	.5479	.5497
				Mean:	.54898

Rise per minute,	.54898
Correction for stirring,	— .00044
Correction for stem,	+ .00140
Corrected rate,	.54994
$C^2 R$	log, 9.517206
R	log, 9.038541
C^2	log, .478665
C	log, .239332
K_c	.02450
K_{50}	.1847@22°

Probably the greatest source of error in the calorimeter experiments was the superheating of the wire in the water. Using platinum-iridium wire varnished, with a smaller current than was generally employed in these experiments, Mr. L. B. Fletcher calculates[8] that the superheating is about 2° C. But in the measurements described above the wire was bare and the flow of water past it very much faster than in Mr. Fletcher's work. In the last two experiments a rise of 2° C. would cause an error of less than one-tenth per cent., so it is probable that they are not much affected by this source of error.

It is also possible that there was conduction through the water. The calorimeter was carefully cleaned before each experiment and distilled water used. If such an effect existed, it would be in an opposite direction from the superheating.

The usual range of temperature was 10° C.; in the experiment given it was a little over 6°.

Besides the regular calibrations, the constant was calculated after each test, from the potential at the extremities of the german silver "dead resistance," the current being measured by the current galvanometer, and the resistance measured by the bridge. The following partial list of calibrations excludes measurements made in this way. It

8. *American Journal of Science*, July, 1885.

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includes the time during which most of the tests were made—from June 11th to June 23d :

Date.	Value of K_{25}	Constant Used.	Method.
June.	at 25 degrees.	at 25.	
11	1.845	1.847	Voltameter.
11	1.8465	1.847	Voltameter.
12	1.847	1.847	Voltameter.
12	1.847	1.847	Voltameter.
13	1.844	1.844	Voltameter.
14	1.842	1.844	Voltameter.
16	1.843	1.844	Voltameter.
17	1.843	1.844	Voltameter.
18	1.845	1.844	Voltameter.
19	1.8434	1.843	Calorimeter.
19	1.844	1.843	Voltameter.
20	1.8485	1.843	Calorimeter.
22	1.843	1.843	Voltameter.
23	1.843	1.843	Voltameter.

For the Edison Nos. 5 and 10 dynamos, the potential galvanometer was in the same position as when used for the duration test of lamps, in a room at some distance from the test house. The constant as determined during the tests of these machines agreed closely with that used in the duration tests, which had but just ended. But when the instrument was removed to the test house, the constant began to vary, changing greatly from day to day, with sometimes a sharp change during the day. The Weston No. 7 M dynamo was tested on full load with the constant in this unsatisfactory state, and between the second and third tests there was a change of over one per cent. Although the number of calibrations made these measurements perfectly trustworthy, yet the labor and anxiety were both too great to be repeated with each test.

So before the machine was run on the partial loads, the galvanometer was taken to pieces, the coils rewound and soaked in paraffine, and the stand of the tube carrying the suspension more firmly secured. A beam, which pressed against the wooden pier, was also cut away. After this, the constant did not vary, the calibrations rarely differing more than one-tenth per cent. from the constant used.

MEASUREMENT OF CURRENT.

The currents were measured by observing the ratio of the potentials at the ends of a fixed resistance when a known current and the current to be measured were passing respectively. To do this, the terminals of a circuit containing a galvanometer and a resistance box were permanently fastened to the extremities of the fixed resistance. A current was sent through the latter, and the resistance of the box adjusted until the proper deflection of the galvanometer was obtained; the current was measured by the voltameter, tangent galvanometer, or calorimeter, and the deflection and resistance was observed. When any other current was to be measured, the box was changed until the deflection was about the same as before, and both the deflection and resistance noted. The thermometers used in getting the temperatures of the different parts of the circuit were those by Green, already described.

The notation and formulæ used are as follows:

Let C' be the current used in calibration ;
r' be the resistance used in calibration ;
d' be the deflection used in calibration ;
t'_s be the temperature of fixed resistance at calibration ;
t'_b be the temperature of resistance box at calibration ;
t'_g be the temperature of galvanometer at calibration ;
C'' be the current to be measured ;
r'' be the corresponding resistance ;
d'' be the corresponding deflection ;
t''_s be the corresponding temperature of fixed resistance ;
t''_b be the corresponding temperature of the box ;
t''_g be the corresponding temperature of galvanometer ;
t_o be the standard temperature = 25° C.;
u_g be the temperature coefficient for galvanometer circuit ;
u_s be the temperature coefficient for fixed resistance and box ;
G be the galvanometer resistance ;
k be the constant at 25° C.

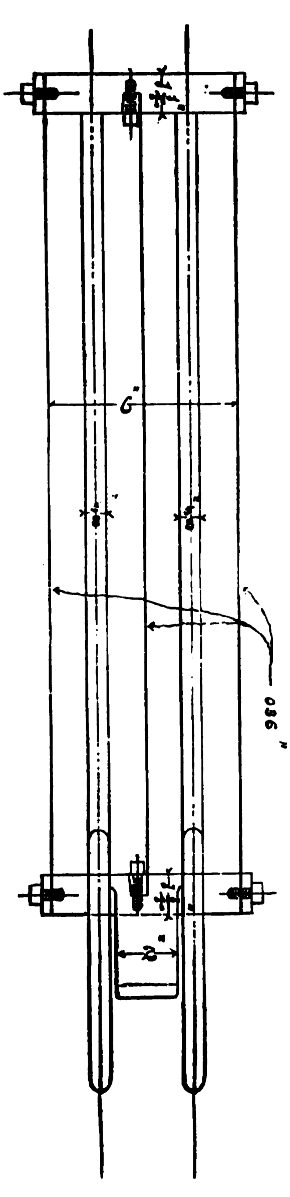

FIGURE 4.—Plan.

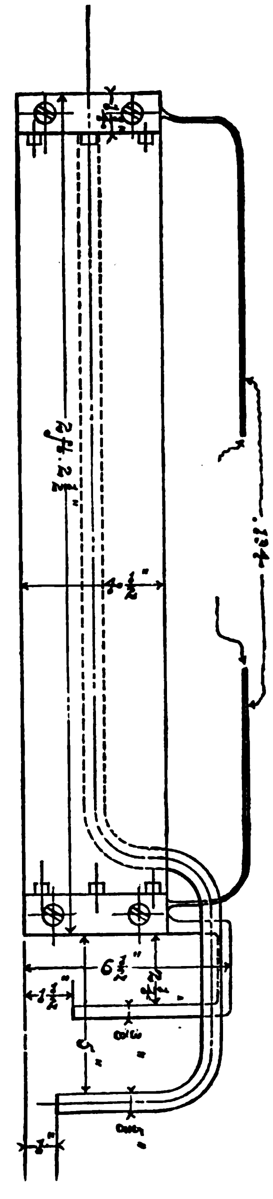

FIGURE 5.—Side elevation.

Then

$$k = \frac{C'}{2d'} \frac{1 + u_s(t'_s - t_o)}{[G\{1 + u_g(t'_g - t_o)\} + r'\{1 + u_s(t'_b - t_o\}]}$$

$$C'' = k\, 2d'' \left[1 - u_s(t''_s - t_o)\right] \left[G(1 + u_g(t''_g - t_o)) + r''(1 + u_s(t''_b - t_o)\right]$$

Calculations were facilitated by making tables of

$$G\{1 + u_g(t_g - t_o)\}$$

for the different temperatures, of

$$r\{1 + u_s(t_b - t_o)\}$$

for the different resistances that were to be used, and of

$$1 - u_s(t_s - t_o)$$

for the different temperatures of the fixed resistance.

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Galvanometer.—A mirror galvanometer, by Edelmann, of Munich, was used. It was furnished with a ring magnet damped by surrounding copper blocks. The suspension, originally about two feet long, was shortened to about seven or eight inches by a copper rod passing inside the glass suspension tube; there was no trouble from vibrations. The coils were movable on graduated bars, but for the tests they were clamped and their position never changed. The resistance of the coils, with the fixed resistance and the leads to it, was

.3973 ohms, at 25°.

This was taken as G in the formulæ, and the temperature coefficient for copper used; the value of the german silver fixed resistance being only about .0004 ohms, and the rest of the circuit being copper. The galvanometer was read with a mirror and scale, the latter being of porcelain, graduated to centimetres and millimetres. The distance from the galvanometer was 2.5 metres.

Resistance Box.—The resistance box, by Hartmann, being open at both ends and having no paraffine on the coils, was very well fitted for its work. Its measurement has been described.

Fixed Resistance.—The details of the fixed resistance are shown in figures 4, 5 and 6, which are respectively, a plan, side elevation, and end view. It is also shown in perspective in figures 2 and 3. It consisted of three strips of german silver, 4½ inches broad by ·036 inches thick, the ends hard-soldered into heavy copper blocks.

One of the blocks had a terminal piece cast on it that was bent to clear the edge of the tank in which the resistance was placed, and dipped into a mercury cup, to which one of the main leads was brought. From the other block, two copper rods passing between the strips, were bent over the edge of the tank and dipped with the other main lead into another mercury cup. The terminals of the galvanometer circuit were soldered into the copper blocks and remained permanent during the tests. The whole was put in a rectangular tank filled with the same kind of oil as was used for the potential resistance.

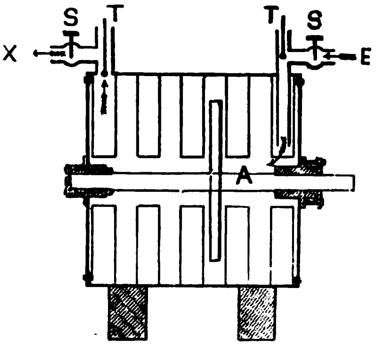

FIGURE 6.—End view.

Calibrations.—Calibrations were made by sending a current through the fixed resistance, measuring it, observing the deflection of the galvanometer and the resistance in its circuit, and noting the temperatures. The calibrations usually lasted ten minutes. The constant was calculated by the formula already given.

Three methods of measuring current were used; the silver voltameter, tangent galvanometer and calorimeter.

For the voltameter calibrations, a large platinum dish was used as cathode, a flattened spiral of silver wire wrapped with filter paper as anode, while a forty to fifty per cent. solution of silver nitrate was employed. With this strength of solution and with the usual current, about four ampères, the deposit was very regular and beautiful. It was treated as described under potential measurements. The resistance in the circuit was about 10 ohms.

The tangent galvanometer has been already described. Two observers read both ends of the needle on each side of the zero mark. The current was reversed every minute; it varied from 20 to 30 ampères.

The method of using the calorimeter has been described. The observations give $C^2 R$, and R being measured by the bridge, C may be found, with the advantage that errors of observation are halved in the value of C.

Altogether, there were five calibrations by the tangent, nine by the voltameter and five by the calorimeter. The following are the values obtained:

.024510	by voltameter.
.024510	by voltameter.
.024440	by tangent galvanometer.
.024550	by tangent galvanometer.
.024510	by voltameter.
.024480	by voltameter.
.024590	by tangent.
	by calorimeter.
.02455	by tangent.
.02455	by voltameter.
.024481	by calorimeter.
.024477	by calorimeter.
.024520	by tangent.
.024500	by voltameter.
.024516	by voltameter.
.02453	by calorimeter.
.024495	by voltameter.
.024494	by voltameter.
.02450	by calorimeter.

This principle of measuring current has been used before, notably at the Vienna and Munich exhibitions, but as employed in the following tests the method differs from that previously used in an important particular, *i. e.*, the construction of the fixed resistance. The substitution in the fixed resistance of german-silver strips in oil instead of the copper bars in air formerly employed, increased greatly both the range and accuracy of the method.

As the method has not been commonly used, and is possibly not very generally understood, a brief discussion of the sources of error and their probable value in these tests will be given.

The possible sources of error are:
(1.) In observing the deflections;
(2.) In the constant;
(3.) In the temperature correction for fixed resistance;
(4.) In the temperature correction for resistance box;
(5.) In the temperature correction for galvanometer;
(6.) In the values of the coils in the box;
(7.) In the resistance of the galvanometer coils;
(8.) In assuming the currents proportional to $2d$.

(1.) Error in observing the deflections.

This error would enter directly in the result. The scale could be read with considerable accuracy to tenths of millimetres; the double deflections were usually between twenty and thirty centimetres. The currents measured were quite steady, but even if they varied, the excellent damping of the galvanometer would allow the readings to be taken with a good deal of precision.

(2.) Errors in the constant.

On looking at the table of constants, it will be seen that the results obtained with different resistances in the galvanometer circuit, different currents, temperatures and deflections, and by entirely independent methods of measuring currents, agree so closely that their mean must be very near the true constant. Two of them, exceptional ones, differ from the mean by one-third per cent., a few more by one-sixth per cent., but the greater number are within one-tenth per cent. of the constant used. Double weight was given the voltameter calibration, as involving less possibility of error than the other methods; with two exceptions, they are within one-fifteenth per cent. of the mean. Any error would enter directly.

(3.) Errors in the temperature correction of the fixed resistance.

The uncertainty due to the temperature correction of the fixed resistance must have been inappreciable. Its temperature coefficient was small, about one-tenth that of copper, while its temperature, considering the large surface of very thin metal exposed to the liquid, must have been quite accurately known. For the heavier currents, the oil was con-

stantly stirred. With about 400 ampères in the circuit, the thermometer registered .1° C. more when held against the strip than when in the body of the liquid; while the oil rose 1.5° during the test. To further decrease the possibility of error, the oil was kept within at the most 5° or 6° of the usual temperature of calibration by cooling it when necessary between the tests. An error would enter directly in the results.

(4.) Errors in the temperature correction of the resistance box.

Both ends of the box were open to the air and the coils were not coated with paraffine. The bulb of the thermometer lay against or very near the coil in use. The currents could cause no appreciable heating and the temperature of the room changed slowly.

The temperature coefficient was taken as

$$.0004,$$

and calibrations made at different temperatures showed that this was not much in error. Errors would enter almost directly in the result.

(5.) Errors in the temperature correction of the galvanometer coils.

The temperature of the galvanometer coils was given by a thermometer hung near them. With the smallest resistance used, any error in this correction would only enter as one twenty-fifth in the result.

(6.) Errors in the values of the coils in the resistance box.

The measurement of the resistance box has been described. The values were probably correct within one part in 2,000 or 3,000. Any error would enter directly in the result.

(7.) Errors in the resistance of the galvanometer circuit.

The resistance of the galvanometer and its circuit was measured by the standardized bridge. The error was probably small and entered at the most as one twenty-fifth in the result.

(8.) Error in assuming the currents proportional to $2d$.

This error is slight and was to a large extent eliminated by making the calibration on about the same part of the scale as the measurements.

The only errors then that would be appreciable are in the deflections, the constant, the temperature correction of the box, and the values of the resistance coils. The last of these could hardly have been over one-twentieth per cent.; the temperature correction of the box was probably within one-tenth per cent.

This method has several advantages. The range is very great (with the apparatus described currents of from two or three ampères to 400 could be measured with about the same accuracy) while the errors are not multiplied in the result and are of such a nature that with proper precautions many of them can be almost entirely eliminated, and the rest made very small.

Although in measurements of both potential and current any change in H would directly affect the results, yet as certainly two and usually more voltameter calibrations were made for each day of the tests, and the constants were checked after each measurement, it is not probable that any important error arose from this cause.

It is also interesting to note that the magnetometer records that showed such irregularities during the life test of lamps just finished, were remarkably uniform during the dynamo tests.

(*To be continued.*)

EXPERIENCE WITH SUBTERRANEAN LINES.[1]

BY DAVID BROOKS.

With this memorandum I leave with you, numbers of the Journal of the Society of Electricians and Telegraph Engineers. These papers give a very complete history of underground electrical work in England and France. You will find there have been very many attempts to use pitch, asphalt, bitumen, coal tar, or whatever name you please to give it. They are essentially the same. Many of these experiments were made more than twenty years since, and Mr. Cully in the eighth edition (just issued) of his work, gives the substance of all these trials in the following words:

"It has often been proposed to insulate underground wires with bitumen but so far without success."

When I appeared before this committee at a previous meeting I referred to the many attempts to insulate wires drawn into lead pipe. These wires have been wound with cotton and the pipe filled with melted rosin, asphaltum, bees-wax or paraffine.

I take the credit of ascertaining the prime cause of the failures. Page 34 of numbers 13 and 14, vol. 5, of these journals give an account of an experiment with paraffined wires in lead pipes made by the post-office authorities in London in 1875.

A Swiss firm secured a patent for molding lead in a cold or unmelted state over these paraffine cables and gave samples for trial to nearly all European governments. The tests were unsatisfactory as moisture would go through the pores of the lead. They next wound an insulating covering, consisting of jute soaked with tar, over the pipe and then molded a second covering of lead over the whole with better results. I show you a specimen, or rather a cut, of this device to protect an electric light conductor. See figure 1.

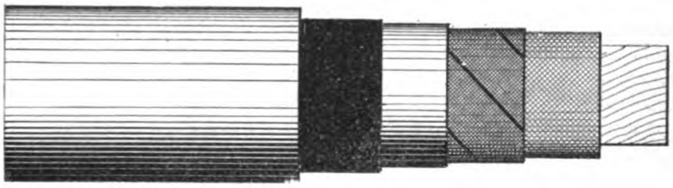

FIGURE 1.

Another method of remedying this difficulty is to lay the lead pipes in a trough, and embed them in melted pitch. The objection to the first method, that is, using two pipes with an insulating medium between them, is that it very materially increases the cost. The objection to the second method is that it is next to impossible to remedy a defect in the conductors caused by atmospheric electricity or high tension currents. The whole system would have to be dug up.

You will find by reading the article by Mr. Fleetwood, the engineer in charge of the London system, that one of their greatest troubles is the effect of atmospheric electricity, although their conductors are carefully provided with lightning arresters. These do not always protect the insulation.

The cables crossing the North river often receive injury from this cause. Atmospheric discharges are more frequent in New York and vicinity than in London, but a cable in the North river can easily be underrun, the hole punctured by lightning found and sealed up, and the cable dropped again to the river bottom. But a lead cable covered with pitch and buried in the ground, when injured by lightning is exceedingly difficult or almost impossible to repair.

When a difficulty of this nature occurs to one of the underground wires in London, they let it remain and connect in its place a "spare" wire, the iron pipe in the first place having twice as many wires therein as their present necessities require. When a sufficient number of these wires become defective the whole of the conductors are pulled out and another group inserted. It was the original intention, when one wire failed, to pull it out and replace it with a good one but it was found that this operation often injured the good wires by abrasion, and now, instead of pulling out one, they pull out the whole cable and sub-

1. Read before the New York Commission on Electrical Subways October 13 1885.

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stitute a new group. I have never heard of any of the conductors that I laid in London being injured by lightning although all of them are connected to overhead wires at Clapham Junction, but if they were thus injured the cable is much more easily drawn out of the pipe, since the latter is scoured smooth inside and lubricated with oil.[2] I see it often stated that the underground railways in London afford great facilities for carrying out their underground systems. This is a mistake. Page 41, numbers 13 and 14, vol. 5, of the Journal gives Mr. Fleetwood's reasons why these underground railways or passages have not been used.

Paris sewers are supposed to give great advantages for the underground system, but if you will read Mr. Aylmer's report, it will be seen that it is much more expensive than the London system. For telephone purposes, the authorities charge the telephone company 15 per cent. of their gross receipts. The sewers are a wonderful piece of masonry.

Paris is situated on the two slopes of the river Seine; the sewers were made by tunneling from the shores of the river under the hills and are at a much greater depth beneath the street surface than is generally supposed. In the centre of the sewer, there is a canal with a sidewalk on each side wide enough for three men to walk abreast, but in another sense unlike a canal and more like a mill race because the water flows with great rapidity. This channel is supplied with water at its greatest elevation, and this water runs with such force and in such quantity that all the sewage of the city is quickly carried into the river. I had the pleasure of walking four miles through the sewers and saw no still or stagnant water. The stream in its rapid course keeps the atmosphere comparatively pure.

CONDUITS.

There has been a great deal said about having an open space or chamber under the streets where everybody could go and place their wires. The lowest estimate of the advocates of the cost of such a subterranean chamber is greater than that of a thousand wires already laid by the system I recommend. Bear in mind this is the price of a conduit without a wire or conductor in it. There are over a hundred diversified interests in the overhead wires in New York, and some of these interests are antagonistic. (See court proceedings often reported in the papers —accounts of cutting and seizing each others wires.)

Not long since these proceedings were carried on to such an extent by the agents of the different companies in the state of New Jersey and so at variance with the laws of that commonwealth that they got themselves into jail. Imagine themselves settling their differences as to right of way in an underground tunnel in New York city!

A conduit unless placed below the gas mains is a dangerous thing. Gas leaks into it and when mixed with air, one part gas to about 14 of air, is explosive. There is a short conduit in Philadelphia laid only a short time since but sufficiently long to have startled the business portion of Chestnut street with three grand explosions, throwing heavy cast iron man-hole covers high into the air.

No. 12, volume 4, page 403, states how gas collected in the pipes containing the wires in London causes explosions and injury to the conductors.

It has been proposed to use creosoted wood conduits. These things have had their trial in London also; they soon decay, the street caves in and requires repairing. It is only the cheapest and most perishable kind of wood that will take creosote; such as is known in this country by the name of pine or hemlock. When green, half of their weight consists of sap or water. After being treated they will not last underground nearly as long as oak, chestnut or the more closely grained woods. The earth under the pavement in New York is sand or gravel, and wood, or iron, or even lead is soon affected by the gases working through this loose material; besides the ammoniacal salts and animal impurities working below the surface tend to bring on rapid disintegration and decay. We counteract these influences as much as possible by inclosing the wrought iron tubes in solid pitch. The wooden box is used merely to keep the pitch in place while hot and in a liquid state.

India-rubber is not used in any of the European countries for insulating wires underground or under water. As an insulating material for that purpose, its life is short. All the nationalities have tried it. Several large establishments were erected at great expense in London for the purpose of insulating wires and cables with that material, but they failed in so short a time that these enterprises were abandoned,—notably Hooper's works, costing millions of dollars, which were sold under the hammer, including the great iron steamer the "Hooper" of 8000 tons burden built expressly for laying ocean cables. But for in-door use it answers every purpose, and is so used almost exclusively in Europe. If in this country it had been used instead of cotton covered wires, many disastrous fires would have been prevented, especially since lighting by electricity came into use. Gutta-percha insulation is now almost entirely used for underground and under water purposes.

Twenty years ago the price was not over 50 cts. per lb. now it is worth from three to four dollars per lb. owing to the diminishing supply; and the prospect is that it will become still dearer as no other material yet discovered answers for ocean cables.

The early attempts to use gutta-percha for underground purposes were unsuccessful as you will see by reading these volumes.

The patent for my system was granted on the 17th day of December, 1878, and expires on the 17th day of December, 1895, a little over ten years hence, and then the system becomes public property.

The wires that I have laid during the past six years, have been attended with less failure, than any equal number and length of gutta-percha insulated wires, wherever they may have been laid. I make this statement without fear of contradiction.

A letter from W. H. Preece, government electrician, under date of Oct. 2, 1885, speaking of my London lines says "Your wires are working very well."

The London specimen consists of 40 conductors in an inch and a quarter diameter pipe four miles long, making 160 miles of conductors laid 1880.

A letter from the department of posts and telegraphs, Brussels, M. Bertin, engineer, March 1st, says:

"The conduit which you laid in Bruges, in 1879, has since been subjected to numerous tests which have demonstrated that the high insulating resistances of all the wires had not perceptibly varied since the work was done. The good results which have been obtained have induced the Belgian government to look into the advisability of laying a conduit with a larger number of wires, in Brussels."

I enclose a cut showing the actual space of 420 wires underground in Spring street and now in use by the telephone company. I may also mention an interesting fact showing another advantage of my system. Since we laid our tubes in Philadelphia, about two feet below the surface, the line of these tubes has been crossed by traction or cable railways. A wrought iron tube is easily sprung out of line and by digging our trench a little deeper on each side of the crossing, the tube was sprung downward so as to allow the conduit of the traction company to pass over it without injury to the pipe or the wires contained therein.

2. Many of the defects in the insulation of underground conductors come on gradually, and are developed into total failure of insulation by the battery current employed to operate the conductor whenever a solid substance is used for insulation. The battery current does not produce this effect in oil, as the oil is continually moving, expanding and contracting by changes of temperature, and thereby does not permit the current to centre upon any particular spot. In this respect the cable or system resembles a horizontal thermometer. All the interruptions that we have had from lightning or dynamo currents have taken place in the insulation outside of the iron pipes, generally where india-rubber or gutta-percha was used for connecting with overhead wires.

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Our tube was successfully lowered three and a half feet without any expense to us, but if it had been an electrical conduit of cast iron or masonry, this springing out of line could not have been accomplished.

New York, Oct. 13, 1885.

RESISTANCE OF COPPER WIRE.

BY CARL HERING.

In most text books on electricity, and in many periodicals, values are given for the resistance, or the conductivity, of copper wire, but owing to the difference in the units used, and to the fact that the resistance varies with the temperature, these values are often very unreliable unless the units used and the temperature, are stated in each case. Even if they are stated, the reductions necessary are often so complicated that it is very troublesome to use these values. If they are reduced to the same units, there is frequently a discrepancy found, so that the practical engineer is often in doubt, not only which value to use, but also to what extent he can depend upon it.

To enable the engineer to compare these values better, and in order to get a fair mean value, the writer has collected, in the last few years, a large number of different values given by various authorities, and has reduced them all to the same units in the following table, thus enabling a fair comparison and selection to be made.

The value to which they have all been reduced is what might be called the *specific resistance*, that is *the resistance in legal ohms, of a wire of one square millimetre cross section, and one metre length, at the temperature 0° Centigrade.* Calling this value θ, the formulæ for using it with other units, such as feet and inches, may readily be deduced and can be reduced to such forms as to facilitate calculations very much.

There is also given in the table, the conductivity of the wire calculated from the specific resistance; it expresses the number of times that the copper conducts better than mercury, or in other words, it is the ratio of the conductivity of copper to that of mercury.

In many of the statements from which these values were calculated, the data given was incomplete, so that the writer had to assume certain factors as being most probably the ones understood. In all cases the original data is given, enabling any one to make the calculations, in case the factors assumed are not the correct ones.

In reducing them all to 0° temperature, the following formula was used.

$$R_0 = R_t - R_t\ t^\circ\ 0.0037$$

t° being in centigrade degrees. The constant 0.0037 was taken as a fair mean of a large number of independent statements. It is evident, however, that if a slightly different value is taken for this constant, it will not affect the result very much, as it does not enter as a direct factor.

The factors used in the reductions are as follows:

1 legal ohm = 1.0112 B. A. units.

1 B. A. unit = .9889 legal ohms.

1 legal ohm = 1.06 Siemens units.

1 B. A. unit = 1.0483 Siemens units.

1 ohm as used in Germany = 1.0615 Siemens units.

The first and second values are those given by the secretary of the British Association, on their standard resistances.

It will be noticed that the values coming from the same authority, but compiled from different sources are not alike. This may be due to the fact that they were incorrectly stated in the source from which they were taken by the writer, but it is more probable that they are values obtained from different experiments at different times.

In many cases values are given for pure copper, while in practice commercial copper is always used, the resistance of which is always greater. Several values for commercial copper are given and show what allowances may be made in practice.

The numbers in the first column refer to the paragraphs below, in which the authority and any other remarks are given.

TABLE.

θ = resistance in legal ohms of 1 metre of copper wire, with 1 square m. m. cross section at 0° C.

K = conductivity at 0° C. as compared with mercury at 0° C.

No.	θ	K	Remarks.	No.	θ	K	Remarks.
1	0.01618	58.31	annealed	9	0.01674	56.34	98%
1	0.01655	57.01	hard	9	0.01727	54.61	95%
1	0.01598	59.05	annealed	10	0.01570	60.09	commerci'l
1	0.01633	57.78	hard	11	0.01608	58.85	commerci'l
2	0.01558	60.55	pure	12	0.01583	59.59	pure
3	0.01528	61.78	soft, pure	12	0.01616	58.38	98%
3	0.01566	60.24	hard, pure	12	0.01765	53.45	90%
4	0.01623	58.12	pure	13	0.01573	59.97	pure
4	0.01642	57.45	pure	14	0.01655	57.00	commerci'l
5	0.01631	57.84	pure, soft	14	0.01572	60.00	commerci'l
6	0.01611	58.56	pure	15	0.01528	61.78	soft, pure
7	0.01528	61.78	soft, pure	15	0.01565	60.27	hard, pure
7	0.01565	60.27	hard, pure	16	0.0243		
8	0.01616	58.38	pure	16	0.02386		
9	0.01641	57.49	pure, soft	16	0.01959		

1. Matthiessen. Resistance of one metre of annealed copper wire of 1 m. m. diameter, at 0° C., is 0.02057 ohms. Hard wire, 0.02104 ohms. From Uppenborn's Kalender. In the first two values the ohm is assumed equal to 1.0615 Siemens units, as that is used throughout the book. In the second two the B. A. unit is taken, it being most probably the one understood.

2. Matthiessen. One mile of pure copper wire $\frac{1}{16}$th inch diameter, at 15.5° C., has 13.59 ohms. The ohm is assumed to be the B. A. unit. From the report of the British Association Committee on Electrical Standards, 1873. This value is employed in the table calculated by Mr. Prescott and published in the ELECTRICIAN AND ELECTRICAL ENGINEER, June, 1885.

3. Matthiessen. Pure copper as compared with mercury: soft 0.0162 Siemens units, hard 0.0166 Siemens units. This, no doubt, means at 0° C.

4. Matthiessen. One metre of pure copper wire of one gram weight, at 0° C., has 0.1469 ohms, sp. gr. 8.95. The ohm is assumed to be the B. A. unit. Another value given is the resistance in absolute units, equal to 1642. These values are quoted by Maxwell and Kohlrausch.

5. Kohlrausch. Pure, soft copper has a conductivity at 18° C. equal to 54 approximately, as compared with mercury at 0° C. The ohm is given as 1.06 Siemens units.

6. Pure copper wire, per mile at 60° F., has $\frac{54892}{d^2}$ ohms. The ohm is assumed to be the B. A. unit. d is, no doubt, the diameter expressed in mils or thousandths of an inch.

7. One metre of soft copper wire of one square mm. cross section at 0° C. has 0.01526 ohms. Hard copper 0.01563 ohms. From Uppenborn's Kalender. The ohm is taken equal to 1.0615 Siemens units. Pure copper is no doubt meant.

8. Taken from Sidney B. Paine's table, published in many price catalogues. 1000 feet of No. 16 pure copper wire at 75° F. with a diameter of 0.050820 inches, has a resistance of 4.179 ohms. The ohm is assumed to be the B. A. unit.

9. Taken from a table published in the London *Electrical Review*, Nov. 3, 1883. One metre of No. 16 pure, soft drawn copper wire with a diameter of 0.064 inches at a temperature of 15° C. has a resistance of 0.00824 ohms. The ohm is assumed to be the B. A. unit. The same author states that the best wire used in practice has a conductivity of 98 per cent. of this value; while ordinary good wire has only 95 per cent. Both these values are given.

10. Commercial copper wire, one metre long, and one square mm. cross section at 15° C. has 0.0166 ohms. Uppenborn's Kalender. The ohm is assumed to be equal to 1.0615 Siemens' units.

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11. Quoted as being used in the Siemens factory. One ohm is equal to 48.5 metres of copper wire of one mm. diameter, at 0° C. The same author gives the ohm equal to 1.0493 Siemens units. This value was used in the reduction. Commercial copper is assumed.

12. From London *Electrician.* 100 yards of pure copper wire of d inches in diameter, has a resistance of $\frac{0.003118}{d^2}$ ohms. 98 per cent. copper has $\frac{0.003185}{d^2}$ ohms. 90 per cent. has $\frac{0.003478}{d^2}$ ohms. The ohm is assumed to be the B. A. unit. The values are assumed to be at the ordinary temperature of 20° C.

13. From London *Electrician.* 1000 feet of pure copper wire with a diameter of 0.12849 has 0.6259 ohms. The diameter is assumed to be in inches, and the temperature to be about 20° C. The ohm is assumed to be the B. A. unit.

14. Hesse, one of the largest manufacturers of copper wire in Germany, guarantees his wire to have a conductivity of from 57 to 60. This is said to be above the usual values.

15. One metre of soft copper wire of one sq. mm. cross section, has 0.01526 ohms. Hard copper, 0.01563 ohms. The ohm is assumed to be equal to 1.0615 Siemens units. The wire is assumed to be pure and at 0° C.

16. Three different values determined by Weber in Munich, of copper from different sources to show the variation. The last one is from Hesse, Germany. They are quoted as specific resistances.

Representing the specific resistance as given and defined in this table, by θ, the following formulæ will enable one to calculate either the resistance in legal ohms, the length, or the size of a copper wire, any two of the factors being given.

Let
- R = the resistance in legal ohms.
- L = the length in feet.
- l = the length in metres.
- D = the diameter in inches.
- d = " " millimetres.
- A = the cross section in square inches.
- a = " " " square millimetres.

The temperature is assumed to be 0° C. unless otherwise stated.

$$R = .0004724 \frac{L\,\theta}{A}$$

$$R = \frac{l\,\theta}{a}$$

$$R \quad .0006015 \frac{L\theta}{D^2}$$

$$R = 1.273 \frac{l\,\theta}{d^2}$$

$$L = 1662 \frac{R\,D^2}{\theta}$$

$$L = 2117 \frac{R\,A}{\theta}$$

$$l = .7854 \frac{Rd^2}{\theta}$$

$$l = \frac{R\,a}{\theta}$$

$$D = .02453 \sqrt{\frac{L\,\theta}{R}}$$

$$d = 1.128 \sqrt{\frac{l\,\theta}{R}}$$

$$A = .0004724 \frac{L\,\theta}{R}$$

$$a = \frac{l\,\theta}{R}$$

The temperature correction may be introduced into the equation, but it complicates it considerably. The most convenient way to correct for temperature, is to calculate the resistance at zero first and then correct by means of the formula,

$$R_t = R_0 + R_0\,t\ 0.0037$$

in which t is in centigrade degrees. For reducing from a high temperature to zero, the following may be used:

$$R_0 = R_t - R_t\,t\ 0.0037$$

Neither of these are absolutely correct but are near enough for all practical purposes.

Assuming as a mean value of θ for ordinary good commercial copper, 0.0162 and assuming a mean temperature of 20° C, equal to about, 68° F. the above formulæ may be still further reduced, to the following:

$$R = .0822 \frac{L}{10{,}000\,A}$$

$$R = .0174 \frac{l}{A}$$

$$R = .105 \frac{L}{10{,}000\,D^2}$$

$$R = .0222 \frac{l}{d^2}$$

$$L = 95500.\ R\,D^2$$

$$L = 122000.\ R\,A$$

$$l = 45.1\ R\,d^2 = \text{approx.}\ \frac{90\,R\,d^2}{2}$$

$$l = 57.5\ R\,a$$

$$D = .00324 \sqrt{\frac{L}{R}}$$

$$d = .149 \sqrt{\frac{l}{R}}$$

$$A = .0822 \frac{L}{10{,}000\,R}$$

$$a = .0174 \frac{l}{R}$$

By taking the specific resistance at 0.0157 which, from the table, is seen to be still above many values given for pure, soft, copper, and therefore will not fall much below that of good commercial copper, the third one of the above formulæ reduces to the very simple and convenient form,

$$R = \frac{L}{100{,}000\,D^2}$$

if the temperature is taken at about 60° F.

Furthermore, if the diameter is taken in mils, the formula reduces to the following form, which could hardly be simpler, namely:

$$R = 10 \frac{L}{D^2}$$

in which R = resistance at 60° F. in legal ohms.
L = length in feet.
D = diameter in mils.

The resistances obtained from this formula will be slightly lower than those given in the tables of Prescott and Paine, because the temperature is taken lower, in order to reduce the constant to 10. If they are reduced to the same temperature they will be very little higher than those of Prescott and somewhat lower than those of Paine.

UNDERGROUND CABLES IN GERMANY.[1]

THE question of underground wires, which is now being agitated in American cities, has so far been answered abroad, in the affirmative, that in several countries, and notably in Germany, the underground system has even been

1. *Scientific American* Supplement.

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adopted for communication between distant cities. It was in 1875 that Dr. Stephan, the director-general of German posts and telegraphs, conceived the idea of that great underground network of telegraphic cables which now connects the principal cities of the empire. The favorable results which had been obtained from the cables of galvanized iron wire, insulated with gutta-percha, which were manufactured by the well-known engineering firm of Felten and Guillaume, of Cologne, induced the government to experiment with this cable, and finally, in the following year, to adopt it in the construction of the underground line between Berlin and Halle. This was recognized as simply experimental. The distance between the two cities is 120 miles, though the connecting cable had a length of 175 miles. There were seven conductors in this cable, and consequently a total mileage of 1,225 miles. The work of construction began in March, and was completed during the following July. This line was eminently successful, and demonstrated to the satisfaction of the administration that the rapidity of transmission was adequate, and that the inductive action of the parallel currents would cause no embarrassment. In consequence, the system was extended over the entire empire, and as finished in 1880 had a total length of cable of 4,000 miles, and of conductors of not less than 28,000 miles. A portion of this network was constructed of cables composed of seven copper wires, 0.6 of a millimetre in diameter, and insulated with gutta-percha and Chatterton compound. The size and number of the conductors varied in the different cables, but were usually greater in those of later construction. The joints in the cables occurred, as a rule, once in every kilometre, and were protected by means of cast iron boxes. After the laying of each section, electrical tests were made upon the whole of the cable in place, in order to prove the joints. Ditches to receive the cable were made about one metre deep, except in those places where masonry or rock interfered, and then a depth of three-quarters of a metre was deemed sufficient. In transporting the cables, they were wound on large wooden bobbins, and were protected by a covering of straw and sheet iron. Since the establishment of the system, electrical tests have been made once every month, and show that in some cases the insulation has improved, while the oldest cable, laid about nine years ago, is as good to-day as when first laid. The cables of the entire system have been manufactured by the same firm, and have cost, in position, about $7,800,000. The example of Germany has since been followed by France, where underground cables are largely in use. They give, as a rule, the same rapidity of transmission as the aerial lines, and, from their protection from the atmosphere, are much more durable. Since the introduction of the telephone and electric light, Messrs. Felten and Guillaume have made enormous quantities of cables for these purposes. Those surrounded with lead, and insulated with impregnated hemp, are well known in the electrical world. The wire cables used on the San Francisco cable roads are also of their manufacture, and show that this well-known firm have been able to attain excellence in several directions.

In some tests made with small squares of various woods buried one inch in the ground the following results were noted: birch and aspen decayed in three years; willow and horse chestnut in four years; maple and red beech in five years; elm, ash, hornbeam, and lombardy poplar in seven years; oak, Scotch fir, Weymouth pine, and silver fir decayed to a depth of half an inch in seven years; larch, juniper, and arbor vitæ were uninjured at the expiration of the seven years.

AN IMPROVMENT ON CREMATION.

A PROCESS of preserving bodies by electroplating has been invented in France by M. Kergovaty. Successful tests have been made upon 11 human bodies, which leads to the hope that in the future we may have statues of our public men, which will be perfect, and possibly proof against the aspersions of the newspaper critic.

EXPERIMENTS ON TRANSMISSION OF POWER BY ELECTRICITY BETWEEN PARIS AND CREIL.[2]

BY M. MARCEL DEPREZ.

I AM happy to announce to the Academy that the first experiments on the transmission of power by electricity have taken place, and that the results have been very satisfactory.

The length of the telegraphic line connecting the two stations is 56 kilometres, but as the return of the current does not take place by the earth it is really obliged to traverse a line of 112 kilometres of copper cable, equivalent in section to a single wire of 5 millimetres in diameter.

The total electric resistance of this cable at the temperature of 15° C. is 100 ohms.

The generating machine is at Creil. It has two rings revolving in two distinct magnetic fields, each composed of eight electro-magnets. Each ring has a resistance of 16.5 ohms and an external diameter of 0.78 metre.

The current produced by this machine was utilized at La Chapelle by two recipient machines, situate at some hundreds of metres from each other. Only one of these recipients is at present completed. It possesses, like the generator, two rings; they have each 0.58 metre exterior diameter and an electric resistance of 18 ohms.

The experiments, begun on October 17th, took place on a looped circuit; that is, the generating and recipient machines were placed side by side, as took place in the experiments made in March, 1883, in the works of the Railway du Nord, by a commission nominated by the Academy. The objections which certain persons have raised to this manner of experimenting, which is much better adapted for scientific verification than the transmission to a distance, have been declared groundless by Tresca, with the reservation that we take, be it well understood, all the necessary precautions for measuring, during the experiment itself, the real resistance of the line, which has been actually done.

Between the generator and the steam engine which sets it in motion there is introduced a very exact dynamometer, analogous to White's dynamometer, which inscribes at each instant upon a band of paper the mechanical work absorbed by the generator. This dynamometer has been devised by M. Contamin, the engineer of the Northern of France Railway Company.

The recipient is fitted with a Prony brake, in which the heating of the friction pulley is rendered impossible by means of a circulation of water. This brake remains in perfect equilibrium for entire hours. Buss tachymeters show at each instant the speed of the generator and of the recipient. These speeds, however, remain constant during the entire duration of an experiment.

We have, therefore, all the elements necessary for determining the mechanical work absorbed by the generator as well as that reproduced by the recipient.

As for the electrical measurements, they have been taken by means of three galvanometers, perfectly graduated, and which show the difference of potential at the brushes of the generator, the difference of potential at the brushes of the recipient, and the intensity of the current traversing the two machines and the line. Two other instruments, lastly, serve for measuring the intensity of the currents produced by small exciting-machines, used for producing the magnetic fields of the generator and the recipient. The indications of all these instruments are of a great exactitude.

I will give in a future communication very complete tables, containing all the electrical and mechanical data of the experiments conducted either by M. Collignon, chief engineer of bridges and highways, or by myself. For the present I will content myself with giving the results of one of the experiments of the commission, and of another ex-

2. *Comptes Rendus.*

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periment made two days afterwards in the presence of M. Sartiaux, sub-inspector of the Northern of France Railway, and engineer delegated by the commission of experiments.

FIRST EXPERIMENT.

	Generator.	Recipient.
Speed in rotations per minute	190	248
Electromotive force, direct or inverse.	5469 v.	4242 v.
Current	7.21 amp.	7.21 amp.
Work in magnetic field (in horse-power)	9.20	3.75
Electrical work (in horse-power)	53.59	41.44
Mechanical work measured with the dynamometer or the brake (horse-power)	62.10	35.10

YIELD.

Electrical	77	per cent.
Industrial mechanical	47.7	"

SECOND EXPERIMENT.

	Generator.	Recipient.
Speed per minute	170	277
Electromotive force	5717 volts.	4441 volts.
Current	7.20 amp.	7.20 amp.
Work in magnetic field	10.30	3.80
Electrical work	55.90	43.4
Mechanical work (measured with the dynamometer or the brake)	61.	40.

YIELD.

Electrical	78	per cent.
Industrial mechanical	53.4	"

It will be seen, and it is to this point that I desire to draw attention, that a useful work of 40 h. p. has been developed by the recipient with an industrial yield of 50 per cent., the speed of the generator being only 170 revolutions per minute, and that of the recipient 277. The electromotive force of the generator was about 5,700 volts. In other experiments it has exceeded 6,000 volts. These machines, therefore, develop considerable electromotive forces with very low angular velocities. It will be remarked, also, that the recipient, though having rings of only 0.50 metre in diameter, and being traversed by a current of only 7 ampères, developed a useful mechanical work of 648 kilogrammetres, without any appreciable heating. These are conditions which hitherto have not been realized.

I cannot conclude this note without mentioning the persons whose assistance has rendered these costly experiments possible; above all, Dr. Herz, editor of *La Lumiere Electrique*, who for two years has defended with the greatest energy, and by all the means in his power, the cause of the electric transmission of force to great distances, and thanks to whom, I have been able to undertake the experiments of Munich, of the Northern of France, and of Grenoble.

The present experiments, the first results of which I have laid before the Academy, have been made with the assistance of MM. de Rothschild.

The London *Electrical Review*, from which we copy the above translation, accompanies it with the following editorial remarks:

It is scarcely to be expected that the recent experiments of M. Marcel Deprez, which was fully dealt with in our other columns, will excite the same amount of interest, we might almost say sensation, as the results of his previous experiences between Miesbach and Munich, Vizille and Grenoble, and other places, notwithstanding the fact that they are of a more grotesque and fantastic character. We are now so conversant with matters involving the transmission of power by electricity, that the results obtained through the dogged determination of the French electrician to overcome the many obstacles with which his path has been beset, will fail to arouse any degree of enthusiasm, at least on this side of the channel. What with the Portrush tramway, a similar line between Bessbrook and Newry, the telpher system at Glynde, &c., the public has long been convinced that the electrical transmission of power could be readily and successfully undertaken. We do not, of course, intend to lead our readers to think that the operations carried out in this country can compare in magnitude or distance traversed with those of M. Deprez, but we do mean that had any of our electrical engineers received such support and assistance as has been accorded to him the same thing could as readily have been accomplished in England in much less time, and, we think, in a manner less open to criticism. We notice that M. Deprez still adopts the plan of putting his apparatus in a looped circuit, and this in itself is enough to make one doubt the accuracy of his tests, unless the line were perfectly insulated, which we need not say could not have been the case. To have obtained the results with which the French engineer credits himself, his generator must have been capable of reproducing nearly 80 per cent. in the external circuit of the mechanical power exerted in driving it, and the recipient must have converted nearly 80 per cent. of the electrical energy received into available power. We have not had M. Deprez's figures before us sufficiently long to enter deeply into the matter here, but in a future issue we shall take occasion to go more fully into an impartial examination of his tabulated results. The idea, however, of separately exciting the field-magnets of the motor is an absurdity upon which we need not enlarge, for in practice the motor must decidedly be self-acting in this respect.

We may in conclusion state that, so far as we can judge at the present moment, M. Deprez's figures will not bear a careful analysis.

BUFFALO ELECTRICAL SOCIETY.

At the regular meeting of the Buffalo Electrical Society held at their rooms Friday, November 6th, Prof. A. L. Arey delivered the ninth of his course of lectures, the subject for the evening being "The Divided Circuit."

The lecturer began by deducing the well-known formula for the resistance of a divided circuit,

$$R \frac{r\,r^1}{r+r} \qquad (1)$$

in which $R =$ the joint resistance of the two arms, r the resistance of one arm and r^1 the resistance of the other arm, and continued, remarking that in the majority of divided circuits the several arms or branches are of equal resistance, as in the case of incandescent lamp circuits or of batteries connected in multiple arc. We have in such cases $r = r^1$ and the formula (1) becomes

$$R = \frac{r^2}{2r} = \frac{r}{2}$$

but 2 is the number of branches, and if we let $n =$ the number of branches we may write

$$R = \frac{r}{n} \qquad (2)$$

by means of which we may determine the resistance of any divided circuit.

To illustrate the application of this formula the following problem was solved:

What will be the resistance of 900 incandescent lights, each having a hot resistance of 130 ohms connected in simple multiple arc?

Substituting in the formula

$$R = \frac{130}{900} = 0.144 \text{ ohms.}$$

After applying this principle in connection with Ohm's law to several more complicated problems, Mr. Arey stated that the consideration of a large class of problems seemed to have been overlooked by the various writers on electricity, and gave the following deduction of formula for the determination of the number of cells of a given

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battery which will produce a given current through a given external resistance, and the manner in which they must be connected.

In problems of this kind we have given

C = the current desired.
R = the external resistance.
e = the E. M. F. of the cell.
r = the internal resistance of the cell.

Let

x = No. of cells in series.
y = No. of rows of cells.
P = internal resistance of battery.
E = the E. M. F. of the battery.

By Ohm's law we have

$$C = \frac{E}{P+r} \qquad (3)$$

but the E. M. F. of the battery is equal to the E. M. F. of one cell multiplied by the number of cells in series; hence

$$E = ex$$

substituting in (3)

$$C = \frac{e\,x}{P+R} \qquad (4)$$

and since the maximum current is obtained from a given battery when its internal resistance is equal to the external, we may determine the smallest number of cells which will produce the given current by making $P=R$ in equation (4); hence

$$C = \frac{e\,x}{2\,R} \qquad (5)$$

clearing of fractions

$$e\,x = 2\;C\,R$$

$$x = \frac{2\;C\,R}{e} \qquad (6)$$

The resistance of the given battery will be

$$P = \frac{r\,x}{y} \qquad (7)$$

but since $P=R$ we may write

$$R = \frac{r\,x}{y} \qquad (8)$$

clearing of fractions

$$R\,y = r\,x$$

$$y = \frac{r}{R}\,x \qquad (9)$$

substituting the value of x found in (6) in equation (9) we have

$$y = \frac{r}{R} \times \frac{2\;C\,R}{e}$$

whence

$$y = \frac{2\,C\,r}{e} \qquad (10)$$

and we may obtain the number of cells which must be connected in series by the equation (6)

$$x = \frac{2\,C\,R}{e}$$

and the number of such series by equation (10)

$$y = \frac{2\;C\,r}{e}$$

Of course the number of cells used will be equal to x multiplied by y.

It is evident from an inspection of the formula that the number of cells in series depends upon the external resistance while the number of such series depends upon the internal resistance of each cell.

In conclusion the following problem was solved to illustrate the application of the formulæ:

How many gravity cells will be required to send a current of 10 ampères through a resistance of 5 ohms, and how must they be connected, assuming the E. M. F. of each cell = 1 volt and its internal resistance 1.5 ohms?

Substituting in (6) and (10)

$$x = \frac{20}{1} \times 5 = 100$$

$$y = \frac{20}{1} \times 1.5 = 30$$

therefore the number of cells required will be 3,000, connected in 30 rows of 100 each.

THE TELPHER LINE AT GLYNDE.[1]

On Saturday Oct. 17, was witnessed a practical demonstration of one of the most interesting outcomes of modern electrical engineering which has yet been brought publicly forward. We refer to the opening of the first telpher line erected in this country, on the estate of Viscount Hampden, at Glynde, a small village within three or four miles of Lewes, in Sussex. The directors of the Telpherage Company had invited a considerable number of guests, amongst them being many representative men of science and of the press, together with a sprinkling of ladies and gentlemen from the surrounding neighborhood.

The London contingent went down to Glynde by a special train from Victoria, and on its arrival, at 1.20 P. M., the guests were conducted to the engine house, whence they could obtain a good view of the starting gear and the telpher train. Shortly before 2 o'clock the line was formally opened by Viscountess Hampden, who, on lifting a bracelet with which she had been presented from the table at which she stood, made connection from the dynamo to the line, when the electric locomotive immediately started upon its journey with its attendant train.

As the system of telpherage invented by the late Prof. Fleeming Jenkin, in conjunction with Professors Ayrton and Perry, has been very fully described and illustrated in various numbers of the *Electrical Review*, notably in the issues of Dec. 8th, 1883, and May 31st, 1884, we need now only remind our readers that it has for its object the automatic electrical transport, along an overhead steel rope or rod, of goods, such as minerals, ores, slate, grain, roots, manure, or in general any goods easily divisible into parcels of from 2 to 5 cwt., at a cost greatly less than that of cartage. As a matter of fact the line at Glynde has been constructed for carrying clay at 7½d. per ton to a siding at the railway where it is tipped into trucks waiting to receive it, and conveyed to the works of the Sussex Cement Company, in Newhaven.

The Telpherage company, which possesses the patent rights of Professors Jenkin, Ayrton, and Perry in telpherage, has, as our readers are aware, experimented on a large scale at Weston, on the estate of the chairman, M. R. Pryor, Esq. Prof. Jenkin died in June this year, leaving his plans of the Glynde telpher line to be carried out by Prof. Perry, his successor as engineer to the company. These plans have necessarily been modified somewhat during the erection of the line, but to as small a degree as was possible. The line is a double one, nearly one mile long, composed of a double set of steel rods, each 66 feet long and three-quarters of an inch in diameter, which are supported on wooden posts at an average height of 18 feet above the ground.

The distance apart of the up and down lines is 8 feet. The two ends of the line are of bulb-angle steel, with supports 13 feet apart. Hanging from the rod a train of ten skeps or buckets, drawn by a locomotive, passes on to the charging end, where it is stopped at any desired place. The skeps are then loaded. Each of the ten skeps weigh 101 lbs., and contains 250 to 300 lbs. of clay in dry weather. At the will of a laborer, who touches a key, the train starts, and travels to the railway station at the rate of four to five miles per hour. On the opening day each of the skeps was upset as it came over a railway wagon by a laborer, at

1. *Electrical Review* (London).

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whose will the train can be stopped or reversed; but this upsetting will afterwards be performed automatically. One train will deliver the minimum amount of clay (150 tons per week) required by the Cement company. If necessary, 20 trains can run on the line without its being possible for one train to collide against another, there being an absolute automatic block provided. The trains need no attention when running, as they are governed to run at the same speed up hill and down hill, and there is also the above mentioned automatic block.

The initial source of power is the Ruston and Proctor engine, formerly used in the Weston experiments, and controlled by a Willans's electric governor; this drives a Crompton's 6 "unit" shunt wound dynamo.

The maximum difference of potential is 190 volts; the current for one train is 8 ampères, two trains need 16 ampères, and so on.

The Reckenzaun motors run in parallel arc. The resistance of the rods used to support the train and convey the current is moderate compared with the resistance in each motor, and the motors have an electromotive force which is large relatively to that produced by the dynamo; consequently, there is little difference in the electromotive force available to drive the several motors, whether these are near the dynamo or far from it; extreme constancy is, however, quite unnecessary under the actual conditions of working, which in this respect are unlike those of electric lighting. The speed and power are controlled by a centrifugal governor of novel construction on the locomotive. The weights and springs are so combined as to be in unstable equilibrium at the critical speeds. Thus, at say 2,100 revolutions per minute, the weights will fly out, breaking contact sharply and widely; they will not return till the speed has fallen to say 1,900. By this plan a permanent arc to the contact is avoided. Injury to the contact pieces is prevented by providing a carbon rod as a secondary contact. This rod is very slowly consumed. The plan described not only regulates the speed, but distributes the power in the ratio required by the several motors. While ascending a steep gradient the current will be on for almost the whole time; while descending a steep gradient it will be off altogether; on level lines it may be on for say a quarter of the whole time of running; this plan avoids all waste in shunts or interposed resistances, and has been tested with good results. The current cut off by each governor is too small to injure the dynamo.

It is claimed that the telpher line will find its application in all cases where the traffic is sufficient to pay interest on a small outlay, and is insufficient to pay for the construction of even the cheapest form of railway. The road and trucks closely resemble the road and trucks already employed for over-head wire rope tramways; but instead of dragging the trains along by means of a wire rope, they are driven by very simple electrical arrangements. By employing electricity the following advantages are gained:—The road is simpler and cheaper, as there are no pulleys or working parts, and no second rope is required; the maintenance is cheaper; there is nothing to oil, and no working parts to wear out; the direction of the electrical road can be changed as often as is desirable, so as to follow a winding direction, an object difficult of attainment even to a moderate extent with rope haulage; the gradients in the electrical road may be as heavy as one in eight, and these gradients may vary as frequently as is desired, which is not possible, except with complicated arrangements, in rope haulage; finally, the power required will be less, except in the simplest cases of rope haulage. In addition, the electric power can easily be tapped *anywhere* along the line and used for working agricultural or other machinery simultaneously with the propulsion of the telpher trains. This facility was shown in practice on Saturday last by a small Ayrton and Perry motor, weighing 33 lbs., attached temporarily to one of the posts of the line, working a turnip-cutter.

As compared with light steam railways, the telpher lines have the following advantages:—They are cheaper, requiring less metal than the lightest rails. No earthworks, bridges, culverts, drains, or fences are required. No land need be purchased. Much sharper curves can be employed. No attendant is required to accompany the trains. Telpher lines crossing a farm will not materially interfere with the cultivation of the land.

The same advantages are claimed over electric railways with this further advantage, that the required insulation is easily obtained when the lines are suspended like telegraph wires. The electrical current required for a moderate traffic would be harmless, and in any case the suspended line is well out of the way of mischievous or accidental interference. The power required to work these lines may be obtained from any steam engine or water-wheel. A single train conveying from 10 cwt. to 20 cwt., according to the gradients, will in general require about three horse-power at the source of power.

In some cases, and notably at the stations and long curves, it is desirable to run the trains on stiff rails. Trains driven by electricity along a *single* wheel-path were absolutely novel at the date of the first telpher patent, in which both the flexible and rigid road are described. Full details of both have been worked out and tested in practice, and a trial train at Weston, Hertfordshire, has run some hundreds of miles, and has been seen by numerous visitors.

A line like that at Glynde could now be erected at short notice for a total cost of £1,200, including engine, dynamo, permanent way, stiff ends, and five trains with locomotives, to carry over 100 tons daily. The working cost, including coals and wages of stoker and electrician, and 12½ per cent. on cost for interest and depreciation, would be less than threepence per ton of material carried, the skeps being empty on their return journey.

A double line like that at Glynde, but ten miles long, if heavily worked, will carry material at twopence per ton per mile, the skeps being empty on the return journey. One very important feature in respect of the cost of telpher lines is the fact that the larger part of the cost is due to plant, such as locomotives, trains, and dynamos, which can be increased in proportion to the work required; thus there is a very moderate increase of cost in the rate per ton per mile for a small traffic as compared with a larger one. And on the other hand a line laid down for a small traffic will accommodate a much larger traffic with no fresh outlay on the line itself.

A single engine and plant of dynamos and trains might work many circuits radiating from one centre, and under these circumstances it would pay to erect lines intended only to be worked to their full capacity for a couple of hours each day or for one day in a week. In fact the function of the telpher line is not to compete with railways, but to do cheaply the work of horses and carts.

The day finally appointed for the opening ceremony was not a favorable one. It had been raining heavily early in the morning, and at intervals during the trials an unpleasant drizzle was noticeable, yet the running of the train passed off quite satisfactorily.

STORAGE BATTERY PLATES.

A correspondent of the *English Mechanic* gives the following as the best form for a storage battery :

Lead plates 4x6 inches are bored with very small holes about ⅛-inch in diameter all over, and a flap of lead is left projecting at one end for connections. The holes are filled with a paste of red lead mixed with water, and they are dipped in dilute sulphuric acid (1 to 10) two or three times, and allowed to dry. When dry they are placed in jars containing dilute sulphuric mixed as before. They are then "formed" by passing a current from a dynamo through them, discharging through some resistance, and then charged the reverse way. This is done for several days—sometimes a week. After formation they are always charged the same way.

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LITERATURE.

REVIEWS.

American Electric Manufacturing Company and its American System of Arc Lighting; pamphlet, 42 pages, illustrated. New York: Twenty-third street and Fifth avenue.

This publication, although intended for gratuitous circulation, will be found of much interest to all who are identified with electric lighting, either as producers or consumers. It treats principally of the apparatus furnished by the American company, but the general arguments in favor of electric lighting are clearly and forcibly put.

In his advice to representatives and agents the president states very strongly and properly that the business of electric lighting demands the full time and energies of the individual. It should not be a side issue.

The company undertakes to furnish everything required for the complete equipment of a central station. The number of arc lamps of all kinds used in this country is placed at over one hundred thousand, which, however, is considered but a beginning. The dynamos and lamps now being introduced are of the Fuller-Wood type, and are made at the company's factory, 163 and 165 West Eighteenth street, in this city. The regulations for installations established by the New York Board of Fire Underwriters are given in full, also those of the New England Insurance Exchange. Those desiring to learn the merits of the American system, or general information on the subject of electric lighting, will be supplied with a copy upon addressing as above.

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LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICIAN AND ELECTRICAL ENGINEER, 115 *Nassau Street, New York city.*

WIRE DISTRIBUTION IN CITIES.

[42.]—I have read with much interest the plan proposed by Mr. Ries in your last number, for carrying and distributing electric conductors, etc., in cities, and have been much impressed with the original and thorough manner in which the subject has been handled by him. While not desirous of criticising the arguments made and conclusions arrived at by Mr. Ries, yet there are one or two points upon which some objection may be made. While the system of overhead main and branch ways proposed may do very well for cities not already provided with elevated railways, it is not clear that this system could be carried out in New York and Brooklyn, which are the cities principally affected by the underground legislation, and in which the overhead obstructions in the form of elevated railways, will be more difficult to overcome than the gas and water pipes. I would suggest that if the main and branch conduits were buried *below* the level of the water pipes and sewers, that Mr. Ries's plan of distribution, which in other respects appears to be admirably adapted to the needs of the different classes of conductors for which it is intended, would be open to less objection and be of a more permanent character than if erected above the street surface.

GEO. E. BARRY.

324 S. 4th St., Brooklyn, N. Y., Nov. 19, 1885.

QUESTIONS AND ANSWERS.

[71.] **Treatment of Leclanche Disque Cells.**—H. E. P. writes that he has eight of these cells, which have never worked more than 15 minutes at a time. He has taken the filling out of three porous cups expecting to find them coated, but they were not. He now wishes to refill them properly. Ans.—Place the carbon plate in the centre of the jar; crush a sufficient amount of carbon into various sizes—from the size of a pea down—and pack the larger pieces in layers in the jar round the carbon plate, so that the particles are in firm contact among themselves, and with the central plate. The finer grains should be mixed with three times their bulk of manganese also in fine grains, and as each layer is packed, the mixture should be sifted in to fill the interstices. The fine powder of both ingredients has to be sifted out because it resists the penetration of the liquid. Before filling, the porous cups should be well soaked in hot water acidulated with sulphuric acid to remove any crystallization which may exist in them. Hard or partially glazed porous cups should not be used. The exciting solution should be composed of from 4 to 5 oz. sal-ammoniac and sufficient water to reach to about an inch below the shoulder of the glass jar. The solution is frequently allowed to become too *weak*. If crystals accumulate on the zinc—it is a sign that *more* sal-ammoniac is needed—these crystals are usually an oxychloride of zinc and will not deposit if the liquid is kept at proper strength. A few drops of sulphuric acid occasionally put into the compound in the porous cup will prove advantageous as it neutralizes the alkali accumulating therein. All "open circuit" batteries suffer from overwork. They are not intended for "closed circuits."

CORRESPONDENCE.

NEW YORK AND VICINITY.

Activity of the Competing Quotation Companies.—Another Trial of the Daft Motor on Ninth Avenue.—Electric Light Operations in New Jersey.—Operator Pratt Secures Bail.—What the Brooklyn Subway Commission is Doing.—Progress of the Long-distance Telephone Line.—Gas in a Western Union Man-Hole.

THE competition between the rival "ticker" companies which at one time might have been based upon the difference in the prices of the service, has now become a struggle for the survival of the fittest. As soon as arrangements were completed by the Stock Exchange to furnish quotations simultaneously to the Gold and Stock and Commercial Telegram companies, it was evident that success could be obtained only by the most prompt and accurate transmission. To meet the emergency, the Gold and Stock Telegraph Co. was fortunately well prepared, and on the 3d of November the introduction of the Scott printers was actually begun.

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The number of instruments placed upon a circuit averages 28, or about double the old style. The new circuits are also metallic instead of grounded, a tardy recognition of the merits of this plan, which was adopted in the same field by the Laws reporting telegraph 17 years ago. The first circuits changed were those in the vicinity of the Stock Exchange, and the work is proceeding as rapidly as possible, with the prospect of being thoroughly completed by the 1st of January. The machines are driven by a dynamo current, their speed being fixed at the medium capacity of 174 revolutions per minute, with a possibility of increasing to 250 as the operator acquires familiarity with the key-board.

Meanwhile the Commercial Telegram company has also put its best foot forward, and has made the most of its opportunity. The superior speed of its new tickers over those heretofore in general use by its rival, afforded an opportunity to gain patronage which was promptly availed of. Whatever may be the financial result of this contest it will certainly leave behind it a vastly improved service, which is a far more substantial gain than can be shown by competition in any other branch of the telegraph service.

Another invitation exhibition of the Daft motor was given on November 18, at which two car loads of people were present. With the usual misfortune that proverbially attends trials of this character, a brush burnt out, causing a delay of eight minutes on the trip from 14th to 50th street on the Ninth avenue elevated railway. The return trip was made in seven minutes, the quickest time yet made in a public test. Among those present were Sidney Dillon, Edward H. Johnson, Cyrus W. Field, A. S. Brown, Whitelaw Reid, and about 20 members of the American Society of Civil Engineers It had been announced that this was the final trial previous to placing the motor in regular service on the road, but none of the gentlemen present, were prepared to state officially when it would be put in operation as part of the motive power of the Ninth avenue line.

The Brush Electric Light Co. in Paterson has been comparatively prosperous in its undisturbed occupation of the field, but the people as usual consider themselves heavily taxed, and it is reported that a new company is about to be organized which will supply lights at half the price. This is not carrying out the principles which were so heartily supported at the recent meeting of the National Electric Light Association, where it was the general feeling that fresh fields should be sought rather than cut-throat competition where plants were already established.

The Elizabeth Schuyler Electric Light Co., although not yet in actual operation is progressing with its work, and has put in its bid for the public lighting of the streets of Elizabeth. It offers to supply arc lamps in groups of four, equivalent to 32 gas lights for $125 per year for each lamp, to burn from dark until one o'clock. Poles are now being erected for the installation of private lamps, and it is quite probable that electric lighting will be adopted for the streets if the additional expense is not too great.

Thomas B. Pratt the telegraph operator on the Meadows, through whose mistake the collision of Oct. 8 occurred on the Pennsylvania railway, has secured $5,000 bail for his appearance at trial. Although liable to ten years imprisonment, it is doubtful whether the fear of punishment of this nature will have a tendency to diminish accidents in future. No legislation can secure immunity from human errors.

The Brooklyn Subway Commission has consented to the issue of a joint permit to the fire department and the New York and New Jersey Telephone company, to erect about 300 poles for telegraph and telephone wires in various parts of the city. The telephone company puts up the poles, giving the city a joint interest in them and the right to string its wires upon them. Commissioner Fleeman has granted a permit for the erection of the poles. The telephone company has also begun operations on Fulton street, Brooklyn, for a new conduit, which when complete will run up Main street to Fulton and thence to Flatbush avenue, to Third avenue, to Atlantic street. The new system will not be in operation before January. There are about 9,000 feet of the conduit to lay.

The poles have been distributed through Bayonne city, New Jersey, for the line of the American Telephone and Telegraph Co., but an injunction has been served in the interest of Rufus Storey, a large property holder, which will hinder operations until some kind of a settlement is reached. This line is intended for the introduction of long-distance telephony between the cities of New York and Philadelphia, and its progress will be watched with interest, as the business between these two points is of a character to make the enterprise a success if it can be attained anywhere in the country.

When the underground cables were laid for the fire department last month, connection was made with one of the Western Union man-holes on Broadway. As soon as an opening was made in its side a stream of gas poured out which caught fire from a lantern and severely burned one hand of Mr. Pearce, firm of Pearce & Jones. By rapidly filling in with dirt the flame was soon extinguished. Fortunately no explosion occurred.

NEW YORK, November 20th, 1885.

CHICAGO.

Agitation Regarding the Use of Areaways for Wire Distribution.—Proposed Construction of Lateral Conduits Round the Blocks.—The Milwaukee Authorities Visit Chicago for Information.—An Underground Company in St. Louis with $600,000 Cash.—The Chicago Conduit Company Refunds $10,000 to the City.—Lighting of the City Hall.—Extensive Central Plants now in Operation.—Time Distribution by the Telephone Company.—Mr. Badger's Contract with the American Electric Mfg. Co.—Proposed Illumination of the River.

ELECTRIC light companies and western city councils are still having plenty of amusement in trying to come to some finality in the matter of getting to individual customers. The underground system here was thought to cover it all, and now companies are troubled to get from the main conduits into the buildings. Everything seemed to be running all right, until the idea struck somebody that a little something in the form of a "come-and-see-me" would be appropriate, inasmuch as the electric light people were making such mints of money out of their enterprises! So, to find a good excuse for the enforcement of voluntary contributions, the dear people have set up the hue and cry that the insurance risk would be largely increased by allowing light wires to cross private premises. The scare, or the hint, or both, became general, and it is perfectly astonishing how many of our good citizens have discovered within the past few days that they are liable to be burned in their beds, "now, and immediately," if these incendiary electricians and underground people are allowed to run their cables—even where these are inclosed in iron or other pipes—under the sidewalks and in areas.

Prof. Gray, who, as an eminent electrician and the head of the Underground Conduit company, has given the subject much attention, is perhaps as well posted as any one. In an interview with the representative of one of our daily papers, Professor Gray said :

"The misapprehension on the part of the real estate men and property owners in Chicago regarding the use of areaways in connection with supplying their buildings with telephonic and other electrical conveniences, seems to arise from statements made by unauthorized parties that this company is going to construct its system of conduits under the sidewalks, and in so doing will take possession of and occupy a large portion of the areaway now controlled by the property holders ; and by so doing interfere with the boilers, etc., constructed under areaways for heating and furnishing power for elevators and other purposes. It is also stated that a private corporation is to usurp these rights in spite of the protests of private individuals."

The city's legal authorities sometime since rendered an opinion on the subject of street boundaries which gave the building line, or inner line of the sidewalk as the boundary line of the street—in other words that the walks as well as the streets are included in the franchise of the Underground Conduit Co.

This discovery, and a proposed amendment to the underground concession ordinance was what brought about the present muddle, which a few days will undoubtedly solve, and then the last obstacle to rapid advancement in electric lighting in Chicago will have been removed.

When it is considered that only a very small portion of any areaway or coal cellar will be needed—barely room for a small iron tube or two, to contain all the wires necessary for the electrical supply of every nature—when this will be run as a rule in a right angled corner, the same as a service gas pipe, it does seem that there is much cry and very little wool in this whole agitation.

The proposition has been made and will perhaps be carried through, to arrange for lateral service pipes placed at the upper inside angle of the curb wall and sidewalk flagging, with proper conveniences for tapping these to supply the buildings. These lateral pipes will run thus entirely aroumd the block, so that there will be no necessity for touching them, once they are in, except to connect or disconnect a customer's individual wires.

There will be no running over the roofs when this is finished, and it will do away with the wires running up and down and across buildings; and furthermore, the wires will be out of the weather as well as out of sight—only the dampness will remain to be feared, and that properly cared for is entirely innocuous.

Eighty-five miles north of us is another corporation which is having a great "to do" about electric lights and underground wires. The fact that two electric light companies from here had applied for franchises in Milwaukee has been chronicled in these columns, and the veto of the Badger ordinance was also recorded. Immediately on the failure to carry the question over the veto a second Badger ordinance was drafted for presentation, and also a Sperry ordinance.

Then the committee and several other members of the council, headed by the president, several city officials and a news-gatherer, of course, came to Chicago to look around and see for themselvs. The party were met on the evening of the 2d instant by Mr. Dorsett, and piloted to the Tremont House for supper, which, though

elaborate, was despatched in a strictly business, though cheerful manner—the haste on the occasion arising from the necessity of getting into the street before the electric lights were extinguished. The party left the hotel under the guidance of our city electric light inspector, who was enabled to show them such an exhibition of lights as they had never seen or anticipated, where these are in regular nightly service. The following day Mr. Dorsett went through the entire conduit business, including the manufacture and handling of the Dorsett conduits and a careful examination of the pipes in the streets.

Chief Fire Marshal Swenie also took a hand in chaperoning them through the fire alarm and police systems, so that when they were back on the train and had time to draw a long breath they had something besides politics to occupy their minds and to talk of on their way home.

On the Friday following an ordinance was prepared by the judiciary committee for submission at the next meeting of the council, which grants a franchise to the Dorsett underground company for the city of Milwaukee. This ordinance is thoroughly satisfactory to all who have heretofore been inimical to underground ordinances and systems of all kinds, and will without doubt be passed and signed without delay. By its provisions work is to be commenced at once, and its early completion is assured.

So, too, in St. Louis the organization of a Dorsett underground company has been completed, and the sum of $600,000 to cover the capital stock, has been placed in the Commercial National Bank to the credit of the organization.

In the matter of investigation by our city council into the ways of the Chicago Sectional Underground Company, the matter has so far progressed that the company has seen the error of its ways, and has refunded the $10,000 which the city had paid for conduit privileges for the city wires. The franchise will be amended in due time.

Our city hall was lighted up for the first time on the 9th inst., on the occasion of the regular meeting of the council. The plant is an eminent success in every respect.

At that meeting a communication from property holders was read and referred, asking that the council delay temporarily any action on the sidewalk area question, and await further information from the communicants. It is understood that a huge petition or remonstrance, or something on the subject will be forthcoming shortly which will once more stir the matter from its uttermost depths.

The telephone investigation is a town topic, and, taken in connection with other electrical topics and arguments, makes it quite apparent that we are fast becoming a community of electricians. The next edition of the electrical directory will not be permitted to stop at dynamo runners and repair men, but will have to include *all* the "butchers and bakers and candlestick makers" in the business as electricians.

The Schuyler central plant on State street is in effectual operation and the lights are doing good service.

Chicago can boast of several quite extensive central plants for electric lights. One of these starting from Monroe street runs to Lake, with lights on Clark, Dearborn and Randolph; another commencing between Monroe and Madison runs north and south between Monroe and Washington with lights on Clark, as well as the streets above mentioned; one on State near Washington works its way north past Randolph nearly to Lake, south to Madison and Clark, with lights on all these thoroughfares, and a second plant on State street further south takes in several blocks both sides of the street; while one on the west side near Halsted, runs lights east, west, north and south of the dynamo. In prospective there are several other extensive central plants awaiting only the council's action relative to the sidewalk question.

The Central Union Company has placed in a little box inside the regulator clock at Giles Brothers' establishment one of Oram's time distributors, which gives time on all telephones in their district, five; and in any one of the other districts it can often be caught by secondary induction. Where this can not be done, it is only necessary to ask a connection with some one in district five, and exact time can be obtained at any minute.

The noise of the induction buzzer is not sufficiently loud to interfere with conversation, but is distinct and unmistakeable. The method of designating the ciphers in ten, twenty, thirty, etc., is ingenious. The time being 2.30 for instance, at the instant the second hand completes the minute a sharp, short buzz is heard, then two strokes, and quite soon afterward three strokes of the buzzer. In the case of 2.03 the strokes are the same, but a longer space between the 2 and 3 is the distinguishing feature.

Mr. S. S. Badger, who is the head of the Badger company here, running one of the central plants above mentioned, has heretofore used the Thomson-Houston system for all his circuits. Mr. B. has recently closed a contract with the American Electric Manufacturing Company, which makes him their western agent, with a branch office in Chicago. This arrangement turns over to that company Mr. B.'s plants, not only in Chicago but in several other Western cities, where, according to the *Scientific American*, there are so many people suffering from "adamantine credulity," poor things!

That great drawback and time-wasting institution, river crossings, while a necessity at present, is becoming daily more serious. While it must be granted that the shipping interests are vital to our prosperity, there are thousands of hours lost daily to our citizens, either in starting too soon or arriving too late, in evading or suffering from bridge delays. Heretofore it has been perilous to think of thwarting the sweet will of the shipping interests, but a late ordinance of the council prohibits the opening of bridges from 6 to 8 in the morning and 5 to 7 in the evening. This is looked upon as the entering wedge, and it is now proposed to light up the river banks by electric lights, and then urge an ordinance restricting all outgoing vessels from passing through the river during daylight. Vessels arriving will of course be permitted to make harbor.

There will be considerable commotion when the great day comes; but something must be done soon or a general uprising of the people on this question is imminent. There is too much of it, and it comes too often.

CHICAGO, Nov. 17, 1885.

PHILADELPHIA.

The Baltimore and Ohio Seeking Equal Telephone Rights.—The Electrical Railway Nearing Completion.—Applications for Rights of Way Over and Underground.—Appropriations for City Electrical Work.—Rumors of a Telegraphic War of Rates.—The Novelties Exhibition.

JUDGES Thayer, Arnold and Wilson on Saturday listened to arguments on the mandamus proceeding by the Baltimore and Ohio Telegraph Company to compel the Bell Telephone Company of Philadelphia to put a telephone in the office of the former corporation, at No. 227 Chestnut street, so that it can be used for receiving from its customers telegraphic messages to be sent over its lines. The contention of the telegraph company is that the telephone company does such service for the Western Union Telegraph company, and to deny the same facilities to it is unjust discrimination. The answer of the telephone company is that the Baltimore and Ohio company has no right to exact extra work, as claimed—work that ought to be done by messenger boys.

In addition to this, the telephone company says that it is simply the licensee of the American Bell Telephone Company, and is subject to a contract which the latter has with the Western Union Telegraph Company. By this contract the Western Union has the exclusive right to use the Bell telephone patents, and, therefore, to give the Baltimore and Ohio Telegraph Company the same facilities would be a violation of a solemn contract. To this it was answered that such a contract is in restraint of trade and is, therefore void; that the business of the Bell Telephone Company of Philadelphia, is analogous to that of common carriers, and that, as between it and persons to be served, no contract can intervene, which gives a preference to one over another. The matter was held under advisement.

The American Electric Company are fast completing the experimental line of road on Ridge avenue, between the car depot at 32d and Dauphin streets and West Laurel Hill. The work is progressing at the rate of about 350 feet a day on the south track. The conduit that is being laid is only four and one-half inches wide by nine inches deep, and is laid on concrete, covered with a layer of Portland cement. Sewer connections at intervals permit the washing out of the slot and also carry off the rain water. In the conduit on each side of the slot runs a copper conductor, one-fourth of an inch wide by one inch deep, on the bottom of which runs a grooved piece of cast iron. Running in the slot, supported by two wheels, is what is called a traveler. This is provided with two springs, which run along the cast iron on either side, receiving the electric current.

In the station an engine supplies the generator with power, which is transmitted to the motors, one of which is on each car, by the process above described. Each car is provided with four electric lamps on the inside, and an electric headlight on each end on the roof. The speed is regulated by the man in charge of the car, and it is possible to make it almost that of a locomotive.

The road that is now being laid will probably be in running order by the latter part of next week. It is entirely experimental, but the experiments will last through the winter. The American Electric Company, should the road prove the success they anticipate, will, during the winter, erect shops where they may manufacture their own machines. Those they have at present were made by the Schuyler Electric Light Company, of Hartford, Conn. The estimated cost of an electric railway 10 miles long with 50 cars is $147,000. This includes machinery in the depot and on the cars, cost of laying and cost of material; but not the cars themselves. The total cost of running is $33,494. The cost per day is $92 for the whole line, or $1.84 per car. As opposed to this is the following estimated cost of the cheapest and worst horse car line in the city, estimated as low as the conscience of the president would allow: Cost per year for ten miles of road and fifty cars, $86,775;

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cost per day, $237.74 for the whole line; cost for one car by the day, $4.74. This is exclusive of any salaries. The electrician in charge of the new work is William B. Schlessinger.

The Electrical Committee of Councils met in chief Walker's private office yesterday afternoon. An ordinance authorizing the People's Telephone Company to stretch their wires along the streets of the city was considered and referred to a sub-committee for examination. Another ordinance, granting permission to the American Telegraph and Telephone Company to lay underground pneumatic tubes, conduits and cables under the streets of the city was submitted. It is the company's purpose to run a cable under the Delaware, and lay their wires underground on Walnut street to Fourth and thence to the offices of the Bell Telephone company. This, it is declared, will give subscribers direct telephone communication with New York. The ordinance was directed to be reported to councils with a favorable recommendation.

The appropriation for the department for the year 1886 was considered. The appropriation for 1885 was $84,407. The sum asked for 1886 is $149,200, an increase of $64,793. There are two main items on which the increase is asked. One is for $30,000 for additional electric lamps and the other is for $30,000 for putting the city wires underground. The electric lamps already in use cost the city $39,000 a year, or an average of $182 a lamp. These items were passed by the committee, although several members declare that they do not believe that any practical invention for the successful operation of wires underground has been discovered.

Rumors are again current that the Western Union Telegraph Company propose to inaugurate a vigorous war against the Baltimore and Ohio. The low schedule of rates adopted by the Baltimore and Ohio is to be met by a cut to a 5 and 10-cent rate by its great competition. Ten word messages, according to the statement said to be vouched for by Western Union officials, are to be sent within the territory between Boston, Philadelphia, New York, Baltimore and Washington, and including the New England states, for 5 cents, and the 10 cent rate is to extend from the Atlantic coast to Chicago, St. Louis, Cincinnati and other western cities. The officials of the Western Union in this city say that they have heard of no such scheme, and that they do not believe that such a cut is contemplated.

The regular monthly meeting of the Franklin Institute was held last evening. Professor Houston presented two photographs taken on a dark night by the light produced by flashes of lightning; in which a building and trees were distinctly shown. They were thrown on the screen by the aid of professor Holman's lantern microscope. The duration of the flash by which the plates were secured was estimated at the one three hundredth part of a second.

Mr. H. R. Heyl, of the managing board, presented the statistics of the late Novelties exhibition. The total attendance was 145,000, and the gross receipts $43,000. The expenses have not yet been fully ascertained.

Speaking of the exhibition of 1886, Mr. Heyl said: "It is quite certain that a prominent feature in the display next year will be an exhibition of gas industries. The convention of gas men was held in Cincinnati this year, and will be held in Philadelphia in 1886. At the Cincinnati convention it was considered advisable to consult the Franklin Institute board regarding the incorporation of gas exhibits in the Novelties display, and the board unanimously adopted the suggestion.

PHILADELPHIA, November 19, 1885.

BOSTON.

Public Fire Alarms in Disfavor.—A Visit from the Director of the Paris Fire Brigade.—A Burglar Caught in the Act.—The Police Authorities Investigating the Police Patrol System.—Proposed Electric Tramway between Boston and Nahant.—Public Electric Lighting in Lawrence.—Prosperity of the International Telephone Co.—The Massachusetts Telephone War.—Telephone Rentals to Different Municipalities.—Property of the Telephone Syndicate Attached.—Arraignment of Henry K. Goodwin.—Telephone Stocks.—Long-distance Telephony.

THE Boston fire commissioners are considering the advisability of discontinuing the striking of bells in the city proper in case of fire. All companies of the fire department in this section of the city are permanent companies, and the members are notified of fires by the striking of gongs in the houses of the department. The proposed change would prevent the annoyance now caused to many who live near a fire bell or have offices in the vicinity of one.

M. Paul Garcien, director of the fire brigade of Paris, who is studying the apparatus and methods in vogue in the government of fire departments in this country, was received by a committee of the city government last week and entertained at the Parker House. Since his arrival he has examined, in company with the committee on fire department, the fire alarm telegraph headquarters at the city hall, and viewed the workings of the fire and water departments and the principal apparatus houses. While in the house of engine 22, a house alarm was pulled in from box 81, which brought quickly to view engines 3, 13, 22 and 23, ladders 3, 12 and 13, chemical 2, and hose 5 and 7. The gentleman has been entertained in true Boston style—evening entertainments, drives through our unrivaled suburbs during the day, and visits to all the prominent points of interest have been made.

M. Garcien expresses himself well pleased with the system of the Boston fire department, though he considers that of New York to be conducted under a discipline more strict. The visitor much admired the comfortable quarters furnished to the firemen in the larger American cities. He has left Boston to visit Philadelphia.

"The alarm sounded," so a burglar found to the cost of his personal liberty Nov. 7th, as he entered a gentlemen's furnishing store on Court street, the patrolman for the Boston Electric Protective Association hastened to the scene and found the man caged and unconscious of the signals he had sent in. The alarm was connected with a bulkhead which the burglar lifted.

Chairman Whiting, of the police board, accompanied by police commissioner Osborne, superintendent Small, and Mr. Irving, chief-clerk of the police board, are on a trip to visit Philadelphia, Chicago, and other cities. The object of the tour is to inquire into the working of the police signal system in the cities mentioned, with a view of adopting the same or some other here.

A company has been formed to run tram-cars by electric motors between Lynn and Nahant. The Nahant people want more conveniences in this direction. The Boston and Lynn horse railroad company was the first petitioner for track locations, and therefore opposes the new company. It is thought that the Nahant people prefer the electric scheme.

It is reported that the International Bell Telephone Company (limited) has the money for another 2½ per cent. dividend in January. This company operates in Europe. In its financial statement of June 18, the company expressed confidence in its ability to pay 5 per cent. on its capital of $1,387,000 in 1885, and the above report is in accord with this expectation.

The protest against the increase of telephone rates has continued during the past month. The total loss to the company by removal of instruments will not be great, as it is probable that the increased rates will fully if not more than offset the loss in rentals from such removals.

A lively meeting was had in Worcester. About 100 gentlemen were present. William H. Earle presided, and J. P. Cheney was secretary. Mr. Earle read a committee report claiming that the cost of a telephone station, exclusive of the royalty paid the Bell company, should not exceed $25 yearly, and that the royalty of $14.60 was exorbitant. The managers of the local exchange claim that the average cost of maintaining the service in Worcester last year was over $45 a station. After speeches by G. L. D. Newton, Alderman Thayer, Alzirus Brown, C. G. Parker, J. C. French and others, in which complaints of poor service were as loud as those against advanced rates, the subscribers present voted unanimously to order their telephones out November 15, unless the old rates were restored and the company gives guarantees of better service. It was stated at the meeting that a paper to this effect has already been signed by more than one-third of the subscribers to the Worcester exchange.

More than a hundred telephones are used by the various departments of the city of Boston, some of them being on special wires. In consideration of this large number, and of the valuable privileges granted to the telephone company, the city fathers have thought that the company would allow some reduction from the regular rates paid by other subscribers. Such allowance has not been made; the city pays the regular price and receives no special privileges. Last year the city's telephone bills amounted to $12,881.58. The city cannot dispense with the telephone service, which is of special value in the police department, but Mayor O'Brien thinks the charges are excessive, and he has been in correspondence with the mayors of other cities in regard to the rates for telephones elsewhere. The charges in various places are shown by the following table:

	Rates per year. Subscribers.	Rates per year. Cities.		Free telephones granted cities.
Albany	$...		$ 60	..
Baltimore	100	Ordinary	67	..
		Fire department	30	..
		Water "	100	..
Boston	120		120	..
Brooklyn	100	Ordinary	90	..
		Leased instrument	20	..
Cincinnati	100		..	..
Chicago	125		10	25
Cleveland	72		20	20
Detroit	..	One-half usual rates.		..
Lawrence	75		36	..
Lowell	75	One-half usual rates.		..
New York	150		150	..
New Haven	60		..	..
Portland	75	One-half usual rates.		2
Providence	60	One-half usual rates.		3
St. Louis	100		100	..
Worcester	75	Instruments at special rates; connect free.		..

In Cincinnati, Cleveland, Detroit, Portland and Worcester the city has the right to use poles for department wires. In Chicago

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the city maintains the leased lines and the telephone company maintains the free lines. In Lawrence it is agreed that the rates paid by the city shall not be raised. In Lowell the fire and lamp departments pay $25 a year. In St. Louis the telephone company pays two and a half per cent of its gross receipts to the city until 1890; after that the company is to pay five per cent. In New York, as in Boston, no privileges are granted, and no reduction from the regular price is made.

The committee on streets, Lawrence, Mass., held a meeting Nov. 12, to consider the petition of nearly 600 residents of South Lawrence to have the city government retain electric lights on the bridges and railroad crossings between Lawrence and South Lawrence. All present were unanimous for retaining the lights. After the hearing, the committee voted unanimously to recommend to the city government that the proposition of the Lawrence Electric Light Company to furnish lights for bridges, the Common and public streets, at the rate of $10 per month be accepted. About 20 electric lights are now in use.

The property of William A. Ingham, C. J. Glidden, Loren N. Downs, Alonzo A. Coburn and William H. Bent, the original telephone syndicate, has been attached for $150,000 each by General Butler and William H. Anderson, on behalf of the Erie Telephone Company, in a suit to recover $127,000, the amount of money paid for certain properties in the west, in which it is alleged the syndicate committed fraud against the company in that they sold it to the Erie company at an advance of $87,000 above what they paid for it while directors of said company. This is the outcome of a special meeting of stockholders held at Albany in September.

Henry K. Goodwin was arraigned before the Supreme Court at Salem, Nov. 6th, to plead to an indictment for murdering Albert H. Swan, at Lawrence, Aug. 27th. Mr. Swan, it will be remembered, was a prominent operator in Bell telephone stock and territory, and at the time of his death was largely interested in the Molecular Telephone Co. General B. F. Butler and Colonel J. P. Sweeney appeared as counsel for defense. Goodwin answered to the indictment, "I did it, and always said I did." General Butler entered a plea of "Not guilty." The trial was fixed for Dec. 28.

The telephone stocks have been somewhat weak, pending the discussions held before Secretary of the Interior, Lamar, during the last week in Washington. The American Bell stock has fluctuated from $1.72 to $1.75—dividend off. The Erie telephone stock, at the time of writing, is sold higher than that of the New England company; why it should is one of the enigmas of the stock market, as it has short contracts with the parent company which must be renewed to be perpetual ones, when of course the main company will receive a share of stock for the perpetual lease—while the New England company has long contracts and is "married to her lord.

The superintendent of the Boston division of the New England Telephone Company announces under date of Nov. 1: This company has completed direct copper wires from Boston to Worcester, Mass., and Portland, Me., points heretofore reached with difficulty by telephone. Other extra-territorial lines have been reconstructed with favorable results. While delays incident to telephonic communication with extra-territorial points are sometimes unavoidable, all possible facilities will be given to subscribers; and it is believed that the time consumed in securing a connection will compare favorably with other modes of communication.

BOSTON, Nov. 20th, 1885.

ELECTRICAL NEWS AND NOTES.

THE ELECTRICAL SUBWAY COMMISSION.

INVESTIGATIONS AT PHILADELPHIA, WASHINGTON AND CHICAGO.

On Friday, November 13, Commissioners Loew and Hess, with Mr. John Thomson, representing Commissioner Moss, started upon their tour of inspection of subterranean electrical work in the cities of Philadelphia and Washington. They were accompanied by several gentlemen interested in the subject, and the party arrived at Philadelphia early in the afternoon. They were met at the station by W. H. Johnstone, general manager of the American Sectional Electric Underground Co., and David Brooks, representing the Brooks Underground Cable Co. It was arranged that the Brooks system should be first visited, and as the preliminary examination was to consist primarily of a telephone test, Mr. Thomson, accompanied by Mr. Palmer, of the Brooks company, drove to Kensington, the remainder of the party going to the office of the company, 310 Chestnut street, these being the terminals of a line which is about 2½ miles long. The telephone tests proved perfectly satisfactory in every respect when the line was arranged in metallic circuit, but induction was apparent to a considerable extent when the wire was grounded. It is but fair to state that the inductive effects were far more apparent over the regular overhead telephone wires of Philadelphia than they were in the underground wires in either of the cities visited. No attempt was made either to verify connections, or to make elaborate tests of the circuits. After satisfying themselves that telephones were in actual use, as had previously been stated by Mr. Brooks, the Commissioners were escorted to the eastern terminus of the cable, in the basement at Third and Chestnut. At this point the wires are fanned out to a joint-board where the necessary connections may be made. All of the wires used are of small gauge, suitable only for telegraph or telephone purposes. No arrangements for local distribution were shown, although in New York city connecting boxes for the Brooks system are located every 45 feet. Indeed, as used in this city, it is in every way more complete than in Philadelphia, excepting, perhaps, in the length of a single circuit.

According to the state law, as interpreted by the Commissioners, it is essential that the system adopted should be in the nature of a conduit, and for this reason the American Sectional system was examined with considerable interest, it having been devised with a view to the accommodation of all classes of wires. The conduit and the man-holes are of cast-iron, although in special cases, where gas, water or sewer pipes are encountered, the man-holes are built of brick in order that they may be shaped properly, and when built up to the proper point are surmounted by the cast-iron top, with an ordinary cover of the same material. The construction is in sections, the man-holes being composed of iron rings several inches wide, placed one above another, to such height as may be necessary. At such points as may require a junction with a lateral, a ring is used having a "spigot," to which the conduit is connected. By this system of construction it is obvious that the man-hole may accommodate a conduit brought in from any direction or at any height. Those in Philadelphia vary in depth from say four to eight feet. The conduit is made in four sizes, designated as A, B, C and D. The outside shell is cast in sections about four feet long, in the form of a trough. These sections are joined longitudinally, the ends breaking joints. The edges are smeared with plumbers' putty after the lower section is laid down. The internal shelves and partitions being put in place the upper section is then placed upon it, and the whole firmly drawn together by a clamp secured by a pin The interior of the conduit is so arranged that the positive wires may run on shelves on one side, the negative wires on the other, while the telegraph and telephone wires are expected to occupy the centre compartment. The two upper compartments are appropriated to local distribution, and are accordingly provided with hand-holes located one in front of each building, covered with about two feet of earth. The trunk lines are drawn through the lower compartments. If, however, a wire is required for house service between the man-holes, it is there selected and led through one of the upper channels, where it is readily accessible when the cover of the hand-hole is raised. House connections are made by boring through from the cellar with an auger and inserting a sufficient length of ordinary gas pipe to reach the conduit. Several hand-holes were opened at different points, one house being selected at random by the Commissioners. The corresponding mark on the curb stone was found and the opening made in fifteen minutes. All were found in good condition. There are about 1¾ miles of conduit laid up Chestnut street from Third to Broad, with two branches. It has been down nearly two years. Considerable trouble was caused at one time by the accumulation of illuminating gas in the conduit, which, being ignited, caused explosions, throwing the man-hole covers into the air. One of these was particularly severe and tore up the street for a distance of three squares. Owing to the apprehensions of danger to life under the then existing conditions, it was decided to introduce a current of air by artificial means in order to drive out the gas. A blower has been arranged for this purpose, and air is now forced into the conduit from the lighting station at a pressure of about three pounds to the square inch. The blower is started about two hours before the lamps are lighted, and the result is perfectly satisfactory, although a complaint was raised last summer by people doing business on Third street in the vicinity of the end of the conduit, that the stench from the gas driven out was very obnoxious.

As there appeared to be no disposition on the part of the various electrical companies to utilize the conduit in Chestnut street, a company was organized under the title of the Underground Electric Light and Power Co., for the purpose of demonstrating that electric lighting could be successfully maintained through underground conduits. For twenty-one months they have continued a system of public lighting on Chestnut street, the only consideration for which has been the use of the dismantled gas posts upon which the lamps are placed. There are six arc light circuits in the conduit for which number four copper wire is used, insulated with pure Para rubber covered with braid and sheathed with lead, the outside diameter being half an inch. The office of the company is at 123 South 11th street, where the arc lighting plant is located. The power is supplied by a double 175 h. p. Cummer engine, run at 120 revolutions per minute. The Arnoux-Hochhausen dynamos have been used heretofore, but the Mather is now being introduced and is highly spoken of. After the lighting circuits were started up, the single telephone and telegraph wires through the conduit were informally tested, but although working satisfactorily, the system was so limited in its

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extent that it did not really prove that the same results would attend the burying of a large number of telephone lines in close proximity to electric lighting wires.

On Saturday the Commissioners witnessed the drawing in of a section of electric light wire between Seventh and Eighth streets. The operation has not as yet become sufficiently familiar to the curious citizen and prevalent small boy to prevent their gathering in considerable crowds to witness the operation. The single wire was drawn in by one man, and was not so heavy as to show any detrimental effect from abrasion.

The Belmont pumping station, at Fairmount Park, was next visited by a portion of the party, the others going to the reservoir, these two points being connected by a subterranean telephone line using the Waring cable. The circuit is also connected with the telephone exchange system of Philadelphia, and by this means is considerably affected by induction. After cutting this off with a ground the underground line was found to be remarkably clear, as of course was to be expected, it being a two wire "anti-induction" cable forming a round circuit, which was grounded where the air line was cut off. Under the escort of chief Walker, the recently established telephone patrol service was inspected. Although not in the line of underground investigation, this branch of the police telegraph system was examined with considerable interest, as it appears to be a very important adjunct of the police department either in small or large cities. Every patrolman within the district which is now equipped is obliged to report by telephone, upon reaching the end of his beat. His voice is recognized and a record made of the time of his visit to each of the patrol boxes, which define the boundaries of his beat. In case a prisoner is captured, instead of taking him to the station he proceeds to the nearest patrol box and calls for the wagon, which starts at the tap of a bell, and like the fire apparatus, is always ready for immediate departure. As the horses take their places the harness is adjusted, the driver springs to his seat, and at the same motion throws open the doors, a sergeant and private jump into the wagon, and the prisoner, whether drunk, sober, crazy or ugly, is soon whirled up with style and despatch. Relieved of his charge, the patrolman at once resumes his duties, and his beat is at no time necessarily abandoned.

Chief Walker, in order to give his visitors an opportunity to learn his idea of an underground conduit, led them through the cellar of the new City Hall, a building which, although not yet completed, has absorbed about $11,000,000 in construction. The quarters of the police and fire telegraph are to be equal if not superior to anything of the kind in the world. The wires are to be brought in underground through an arched conduit of brick and cement, 5x6½ feet in dimensions, and 80 feet in length. A large water pipe is to be laid in the bottom, after which a brick floor will be placed over it, and the walls will be in perfect readiness to permit the stringing of overhead cables or wires "underground."

President Bentley, of the Local Telegraph and Bell Telephone companies, is making preparations to put down over a mile of the Wyckoff pump log conduit, of the same pattern as that used by the Western Union Telegraph Co. in Washington. Mr. Bentley considers the cable devised by David Brooks, Jr., as the most satisfactory for telephone work. The wires in it are supposed to be shielded from the influence of induction by the use of tinsel wire, with which groups of the insulated conductors are wrapped. The whole is sheathed in lead and filled with insulating material—not paraffine. Experience in Philadelphia has not been favorable to the extended use of this insulation.

The city authorities of Philadelphia reserve to themselves the supervision of the electrical lines, both aerial and subterranean, to the extent of specifying the height and size of the poles, the routes of lines, the height at which lamps shall be suspended, etc. Whether or not this may be the reason, it is certainly the fact that overhead wires are more carefully strung than in New York; the arc lighting wires through Chestnut street especially presenting a very neat appearance. In this instance iron poles have been used, which, however, are not quite strong enough for the service.

The city of Washington, which was next visited by the Commission, has been popularly supposed to offer some examples of what has been practically accomplished in the line of underground work. As an engineering problem the difficulties to be encountered are hardly more intricate than would be met on a Western prairie, there being apparently room enough for all companies who desire to undertake the burial of their wires.

Perhaps the best known underground system, and that which has given entire satisfaction to the government officers for two years past, is that of the Waring cable manufactured by the Standard Underground Cable Company of Pittsburg. The pattern adopted for this work is the six wire anti-induction cable, and it is employed in the making up of a combined telephone and telegraph system, by which the various government departments are placed in electrical connection with each other. The character of the buildings, the nature of the grounds, and the satisfaction of having wires which are entirely free from the annoyance of crosses, escapes, induction, and the various evils which beset our best managed lines, are the combined influences which in this particular instance make every officer and employé an earnest advocate of underground wires.

The first office visited on Monday morning was the War Department—the historic "Di," with which are associated the names of Eckert, Bates, Tinker, Chandler, and others, who were identified with this important post during the civil war. Various tests were made with the Capitol, a mile distant, over both Morse and telephone circuits, not for the purpose of attaining exact scientific data, but rather to prove that the system was practically perfect, as has been frequently asserted. Several other offices were visited, among them that at the Executive Mansion, where Mr. Montgomery uses the type writer for copying all messages received by sound. After completing the examination of the government lines the headquarters of the police and fire telegraph were visited.

Those who daily used the Waring cables in telegraphing and telephoning in various parts of the city were unanimous in their praise, and from personal knowledge of the unsatisfactory working of the lines which are generally used for this purpose, there can be no doubt that the improvement is most heartily appreciated.

The Baltimore and Ohio people had little to offer which was new to the Commission. Mr. Stewart stated that he had just finished testing a 600-foot length of the Averell system, in which bare copper wires are embedded in a prism of asphalt and silex. He had found the insulation more perfect than when it was first laid down, but no circuits had as yet been connected through it.

The Postal Telegraph and Cable Company have two wires running through Hurlbut's paper tube system. They had had considerable trouble arising from the breaking of wires in the man-holes, caused by the freezing of water in the winter. Manager Allen did not appear to be very enthusiastic over his wires.

The Western Union Telegraph Company, while it has no subterranean wires, has two "holes through the ground" three-quarters of a mile long. They are made of the cypress pump-logs, which are about six inches square, bored with three inch holes through the centre, and furnished in lengths of from six to eight feet. The wood is put down in its natural state, the ends of the lengths being so fitted that they may be firmly driven together. The completion of this line has been prevented by an injunction, as stated by the Washington correspondent of this journal. It is the only structure in the nature of a conduit which was seen in Washington.

The Chesapeake and Potomac Telephone Co. has placed underground about 12 miles of cable, the larger part of which are of the Patterson, and the remainder of the Phillips pattern. These are placed in 2½ miles of wooden conduit, filled in with asphaltum. Over $50,000 was expended for this work last year, while that remaining to be done will cost about $30,000. The official report of the company states that the cables work admirably, and that out of 1,150 wires leading from the exchange, one line of 700 and another of 450, one used a year and the other six months, not a single wire has become unserviceable from any cause. The distribution of telephone wires to subscribers in Washington is effected through the agency of distributing poles, which the authorities allow erected in the alleys, or in the centre of a block, up which the cables are led. It is rather a curious fact that while, according to the report of the company, "the public authorities have compelled us to transfer some of our lines from the overhead to an underground system," there had been erected in Washington during the previous nine months 295 poles, an increase of *ninety-five per cent*. These poles are generally very large, having a capacity of 50 or more single wires. Owing to lack of time no tests of telephone lines leading into the exchange were made, but so far as could be ascertained the gentlemen in charge appeared to be perfectly satisfied with the working of the system.

The Commissioners returned to New York on Monday, and started for Chicago on November 21.

The investigation of the subterranean systems of Chicago by the same gentlemen, was begun on Monday November 23. Some disappointment was expressed upon reaching the city, to find that apparently as large a proportion of the overhead wires were still in operation as had been found elsewhere, in spite of the fact that the date fixed by law for their final disappearance was as long ago as January 1st 1883. There are, however, no overhead wires for electric lighting purposes, neither are the streets lighted by electricity as yet, excepting to a limited extent by private enterprise.

The general business of supplying facilities for subterranean electrical communication is conducted by the Chicago Sectional Electrical Underground Conduit Co., which was originally organized for the purpose of laying down an iron conduit of the same character as that examined in Philadelphia. About two miles of this was laid in 1883, and a Patterson cable drawn through it where it still remains. The same company has since adopted the Dorsett conduit, which after two years service has been found so satisfactory, that about six miles have been put down during the past season. A very complete description of this conduit, was given in the ELECTRICIAN AND ELECTRICAL ENGINEER of November, in

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the proceedings before the Commission on Electrical Subways.

As now used in Chicago it consists of cylindrical multitubular sections three feet in length, and ten inches in diameter containing seven ducts, each of which are 2¼ inches in diameter. The material composed of asphaltum silex, oxide of manganese and other ingredients, is molded under a continuous hammering process which gives it increased density and adds greatly to its strength, as well as other very desirable qualities for this purpose. The sections with a flange at one end are joined by a cement of the same material, and two lines are laid, making seven ducts for telegraph and telephone purposes, and the same number for electric light and power which are separated by about six inches of earth. In localities where it is necessary to provide for a great number of wires, larger pipes are used. The varieties of service already accommodated embrace the electric lighting, telegraph, telephone, ticker, district and time systems. The wires are usually encased in lead, either singly as in the case of arc lighting wires, or in cables, where conductors of but small size are required. The insulated arc wires used are ⅝ of an inch external diameter, and but four of them are placed in a duct, while for telephone purposes 100 may be accommodated. The Patterson, Waring, Day and Callender cables are used by different companies. The cables and wires could be examined only at the man-holes, which were opened at several points and found to be in apparently good condition. The man-holes, which are usually located at the intersections of streets, are made of the same material as the pipe, are bottle shaped, with a cast iron collar, and double cast iron covers, the exterior one being secured with a bolt and nut, the interior with a padlock. The pipe is joined to the man-hole wherever necessary, by chiseling a hole through its wall, inserting the end of the pipe and cementing the joint. The whole structure is thus made proof against the ingress of water, sewage or gas. An ingenious machine has been constructed for shoving a number four iron draw wire through the ducts from one man-hole to another. The wire is wound upon a reel, provided with the necessary gearing for turning by a crank. The end of the wire is led through a curved piece of gas pipe about six feet in length, and tipped with a traveler shaped like a soldering iron. The pipe is so curved as to lead the wire down from the reel into the end of the duct in the man-hole, which it enters horizontally. As the reel is then turned in the proper direction the wire is rapidly pushed through to the adjoining man-hole. At the corner of North Clark street and Chestnut place, the process of laying a lateral and joining it to a man-hole was witnessed. These laterals lead to the corners of the areas, under the sidewalks, from which the necessary wires are led for service on each block. Objections are being raised by property holders to the system of distribution heretofore practiced, and it will probably be modified to meet the requirements, as would necessarily be the case in other cities. To provide for the distribution of wires to every house, a hand-hole has been devised similar to the man-hole, but of much smaller dimensions, through which the cables are led. From this hand-hole smaller laterals are led, of similar construction to the main pipe, but encased in iron to give the requisite strength. From each of these hand-holes placed in the street, opposite the partition wall, four buildings will be supplied with any required service from the main conduit. The covers will be accessible from the street without disturbing the pavément, and like the man-hole covers are so secured as to prevent the ingress of moisture. A sample hand-hole was shown at the factory, which was next visited by the commission.

The process of manufacturing the pipe was watched with much interest. A sectional mould being placed on end under the plunger, the hot material is introduced in small quantities at about the consistency of mortar, and is immediately tamped by the plunger driven by steam, until thoroughly set, when another portion is added, and the process continued until the mold is full. The whole is partially cooled by a jet of water from a hose, and swung by a crane into a tank of water. The mold previously cooled is then removed from the tank, and opened, the end of the pipe trimmed, and the manufactured product is ready for shipment. At the suggestion of the commissioners a length of pipe was chipped and then broken in order to show its tenacity. Its evident strength was certainly surprising to several of those present who witnessed the test. The thorough manner in which the sections of pipe are manufactured impresses the observer with the idea that a conduit of this description must necessarily possess the qualification of durability for subterranean purposes. Its introduction in Chicago has to a certain extent carried it through its experimental stage, and the experience thus gained should lead to still better results in all future work.

At the head-quarters of the city electrical department the commissioners were shown the very complete equipment of the fire telegraph service in charge of Professor Barrett, who was very decided in his opinion that its efficiency had been increased, and its reliability assured by the introduction of subterranean wires. The first wires placed underground nine years ago are now in perfect order, being insulated with kerite and drawn through iron pipes coated with asphaltum. Prof. Barrett still uses the same class of wire through the Dorsett pipes, some of which are the property of the city, while others are part of the system owned by the conduit company. The telephone company use both aerial and subterranean cables. The tests made with telephones in Chicago, as well as the opinions given confirmed the previous investigations of the commissioners that the underground service is more perfect than usually obtains with overhead wires in cities.

The underground conduits of the Western Union and Baltimore and Ohio companies consist of cast iron pipes and brick man-holes. As soon as the necessary cables are received by the Western Union company, the wires leading from the corner of Washington and Lasalle to Taylor street will be connected underground, and the poles and wires of that company removed within a district covering about one square mile. The wires will not be placed in the ducts of the conduit company, as ample provision has been made for them by a special conduit under the franchise granted to the Mutual Union Telegraph Co.

The city of Chicago is farther advanced in subterranean work than any other place in America, not only so far as the actual operation of lines is concerned, but in preparations for the future. There appeared to be no question raised by practical men as to the successful working of underground wires, because the facts speak for themselves. For a more complete general history of the work, our readers are referred to the September, 1885 issue of the ELECTRICIAN AND ELECTRICAL ENGINEER, which may be relied upon as comprising all the necessary information regarding it, in a more comprehensive manner than can be attained by a brief personal examination of the ground. In fact the investigation of practical underground systems consists principally in the verification of information previously obtained from those who are familiar with their growth. Holes in the ground, or through the ground, present but little surface for satisfactory observation. To pursue the subject further, would require the assistance of a committee composed of rats and ferrets.

THE TELEPHONE HEARING BEFORE THE SECRETARY OF THE INTERIOR.

The hearing ordered by the Honorable Secretary of the Interior on the various applications for leave to bring suits in the name of the United States to cancel the Bell patent, No. 174,465, of March 7, 1876, was commenced at Washington on the 31st of October, before Hon. L. Q. C. Lamar, Secretary of the Interior; Hon. H. F. Muldrow and Hon. G. A. Jenks, assistant secretaries, and Hon. M. V. Montgomery, Commissioner of Patents. Hon. Casey Young, Hon. Bradley T. Johnson, R. J. Morgan and Mr. Humphreys appeared for the petitioners, and J. J. Storrow, Esq., for the respondents, the American Bell Telephone Company.

The Commissioner of Patents, in the temporary absence of the secretary, stated the object of the hearing, and said that three petitions had been filed, two by the Globe Telephone Company and one by the Washington Telephone Company.

In response to a question of the commissioner, Gen. Johnson said he had received notice from the department to appear and discuss two propositions, one as to the authority of the government to institute the proceedings prayed for, and the other as to whether the power being established, this is a case in which it ought to be exercised. He was ready to discuss both these questions. Mr. Storrow, in behalf of the respondents, stated that he proposed to inquire whether the Department of Justice has the power, under any circumstances, to bring such a bill; whether the circumstances are such that as a matter of law it has the power, or whether they are such, as a matter of law and under the decisions of the courts, as to prevent this from being done; and also whether, if such authority exists, it ought now to be exercised. He proposed to show that the most serious allegations of the bill, those of fraud and theft, were not only unsupported by evidence, but were absolutely disproved by the records of the department and the very papers presented by the petitioners. After considerable discussion between counsel, the Hon. Secretary stated that his understanding of the case was, that the counsel for the respondents deny the power of the government in any case to bring suit to vacate a patent regularly issued; they hold that the facts alleged, even if the power exists, do not make a case that comes within the constitutional competency of the government to bring the suit, and that even if they did, they still do not make a case which would justify the exercise of discretion to bring the suit, and finally that the facts themselves are proved by the records of the department and other evidence to be destitute of foundation. Mr. Young, in behalf of the National Improved Telephone Company and the Pan Electric Telephone Company, said that while agreeing in the main with Mr. Storrow, he controverted the proposition that the government had no power to institute a suit in any case. He (Mr. Young) apprehended that the question was likely to assume a magnitude not originally contemplated, and suggested that while he himself did not ask for a postponement, inasmuch as he was quite ready to argue the case as presented, yet if there was to be a postponement, he would ask that it be fixed at a day sufficiently distant to enable the leading counsel of the two companies represented by him to be present. He was confident that if it was controverted, he would be able to show by abundant authority coming down from the English law that it is a duty of the gov-

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ernment, and that it has ample authority under our law and practice to institute the proceedings sought under the state of facts presented. Gen. Johnson said he was ready there and then to try the question of legal power and of fact; he wanted no authority from English courts. He could refer to decisions of the Supreme Court of the United States which would settle the question of law beyond all discussion. The Hon. Secretary said that he doubted whether the question of the legal issuance of the patent could come up before that tribunal. The secretary had no appellate power over the action of the patent office, and it appeared to him that the application to set aside the patent rather conceded its existence as a legal document. As a valid muniment of title, it had gone beyond his jurisdiction, and the only question now was whether he should advise the attorney-general to institute a suit to cancel it.

Mr. Humphreys said that the people he represented (the Globe company) were ready to go into business, but the respondents have such a power over the country that nobody is able to contest them except the government. He was prepared to show conclusively everything alleged in his petition.

Mr. Young suggested a postponement for a week to enable additional counsel from New Orleans to be present. Mr. Storrow thought that while the discussion would not take the range indicated by Mr. Young, it might go beyond a bare technical question of law.

The Hon. Secretary said that the department had notified the parties to appear and discuss certain propositions, which it might have gone on and investigated for itself; that counsel were before him as friends of the department, if they chose to consider it so, in reaching a conclusion, so that in postponing the hearing until another day it was merely consulting the convenience of its advisers. He therefore adjourned the hearing until Monday, November 9th, at 10 A. M.

On Monday, November 9th, pursuant to adjournment, the hearing was resumed. There was a large array of distinguished counsel present, in addition to those who appeared on the former occasion, among whom were Hon. George Gantt, of Memphis, and Hon. E. R. Beckwith, of New Orleans, and S. R. Beckwith, of New York, who represented divers of the petitioners; Chauncey Smith, of Boston, and E. N. Dickerson, of New York, representing the respondents, and numerous others. The room was crowded almost to suffocation with persons interested in one way and another in the proceedings.

Secretary Lamar, in opening the proceedings, stated that nine petitions in all had been filed in this case. Inasmuch as there seemed to be a concurrence of sentiment and wish by all the parties concerned in this controversy that the whole case should be taken up at once and considered as a whole, he preferred that there should be at present no discussion on the question of the power of the government to institute a suit to vacate a patent, and that the respective applicants, who are movers in this matter, should begin with their evidence and submit their cases.

THE VARIOUS PETITIONS SUBMITTED.

The first case called was that of the Globe Telephone Company, and Mr. Humphreys, the attorney for the company, read the petitions filed in its behalf, which set forth that the patent examiner who passed Bell's patent was under the impression that it related to a system of multiplex telegraphy; that he had not the least idea that it described a speaking telephone, otherwise he (the examiner) would have compelled Bell to have submitted the apparatus to a practical test. The device described by Bell in his specification was not and is not a speaking telephone, and this was admitted by Bell himself in a lecture subsequently delivered in London. The electric speaking telephone was not new. The oath of Bell as to his priority was not true. Reis, Meucci and Gray had made and used telephones before his application. Gray had filed a caveat setting forth the electrical art of transmission of articulate speech. The Commissioner of Patents had refused to declare an interference between Gray and Bell, although the records contained no positive proof of the priority in point of time of Bell's application. The petition further alleged that Antonio Meucci, of Staten Island, had conceived the invention of the speaking telephone in 1849, had made apparatus in 1855 and '57, and had published an account of it in 1864. In 1871 he filed a caveat, which he renewed in 1872 and 1873, but had been prevented by poverty, misfortune and disease from patenting or introducing his invention, but nevertheless had not lost his rights as a prior inventor, nor had he abandoned his invention. The pretended litigation under the Bell patent had been collusive. In the Spencer case Bell's priority had been admitted, but Professor Eaton, the maker of the apparatus complained of, was not permitted to testify. In the Dowd case the litigation had been compromised, and the Western Union Telegraph Company, controlling certain telephonic patents, had entered into a contract with the Bell company by which the Western Union company received twenty per cent. of the profits of the telephone company, and these great corporations had united to compel the people to pay tribute to them. Therefore, the Globe Telephone Company prayed the Department of Justice to begin suit to vacate the Bell patent.

Col. Gantt read the petition of the Washington Telephone Company, in which the allegations were substantially similar to the above.

Mr. Humphreys presented and read the petition of Sylvanus D. Cushman, of Ohio, another first, original and true inventor of the speaking telephone. Mr. Humphreys stated that there was a contract in existence made between Cushman and the Bell company by the terms of which Cushman agreed to remain quiet and not interfere with the Bell patents. That document was in the hands of the attorneys for the Bell company, and later on they would be called upon to produce it.

The petition of the North American Telephone Company, representing the McDonough inventions, was presented. It was signed by H. H. Eldred.

The Memphis petition, in behalf of the Pan Electric Telephone Company, was read by Col. Gantt. The allegations were in substance the same as those of the Globe company. It was lengthy and verbose, and was conspicuous for the extensive array of vituperative adjectives which it contained. It alleged, among other things, that Elisha Gray filed a caveat for a telephone on the the same day that Bell filed his application, and that, contrary to law, the contents of Gray's caveat were made known to Bell by an official of the patent office, and that within a few days Bell made an important amendment to his application, covering the matter described in Gray's caveat. Mr. Gantt stated that Solicitor-General Goode had acted upon that petition, after an examination of the authorities upon telephony and of the Reis and other instruments, by beginning the suit at Memphis.

Mr. Storrow stated that the Bell company did not propose to submit a formal answer to the petitions; it was sufficient to deny generally everything that had been set forth.

THE AFFIDAVITS OF THE GLOBE TELEPHONE COMPANY.

Mr. Humphreys then read a number of affidavits submitted in support of the petition of the Globe company, beginning with that of Zenas F. Wilber, an ex-examiner of the patent office, who was in charge of the electrical division at the time the Bell patent was passed. The affiant states that after an examination of Gray's caveat and Bell's application he suspended Bell's application and notified Gray to complete his caveat within three months. Those orders had been overruled by the Commissioner and revoked, and a patent issued to Bell. In all his experience in eleven years' practice affiant had not known of a similar ruling. Had the usual course been followed after the suspensory order, Bell could not have received a patent, and had Meucci's caveat been renewed in 1875 no patent could have issued to Bell. Affiant did not suspect irregularity at the time. He did not suppose that Bell's application was for a talking telephone, but for multiplex telegraphy, and is convinced that his device as described in his original application is inoperative as a speaking telephone.

Prof. A. K. Eaton, an electrical expert and inventor, of Brooklyn, in his affidavit, deposes that the Reis apparatus is capable of transmitting speech. He also described Meucci's invention, and stated that in his opinion Reis was the inventor of the telephone. L. S. Pratt, of the editorial staff of the New York *World*, in his affidavit, corroborates the statements of Mr. Eaton, and declares that Eaton to his knowledge in 1875 constructed an operative speaking telephone.

Prof. Amos E. Dolbear, of Tuft's College, Mass., makes an affidavit that he was told by a mutual friend of himself and Bell, in the fall of 1876, that he (Bell) had patented the magneto telephone two or three years before, and that it did not amount to anything. This statement had discouraged affiant, and he did not at the time carry out his intention of applying for a patent for his own invention of the magneto-telephone. Affiant's instrument had, through the Gold and Stock company, come under the control of the Western Union Telegraph Company, and affiant was not represented at the interference proceedings before the patent office because of the fact that the Bell company controlled his inventions. Attached to Prof. Dolbear's affidavit was a number of exhibits in the shape of letters from a number of college professors testifying to the merits and practicability of the Reis instrument.

Mr. S. R. Beckwith, general manager and counsel for the Globe company, read an affidavit of Antonio Meucci, describing his inventions, and a great number of exhibits in the form of telephones, alleged to be reproductions of actual working instruments made and used by him many years ago, were laid before the secretary to support his allegation. Meucci recounted his struggles against extreme poverty, which, he says, prevented him from taking out a patent for a telephone conceived by him in 1849 while in Havana, and for which he had made a caveat in 1871. A long transcription from his notes of experiments in telephony, ante-dating the Bell patent, was read, and a number of correlative affidavits were submitted, closing the case for the Globe and Washington companies, after which the case was adjourned for the day.

As Secretary Lamar was occupied in attending a cabinet meeting, no session was held on Tuesday.

The proceedings were resumed on Wednesday, Nov. 11, at 10 A. M., the same counsel as before being present on both sides. There were, perhaps, not quite so many patent attorneys and un-

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retained lawyers present as on Monday, but scientific men, inventors, stockholders, speculators and the public generally, showed an unabated interest in the proceedings.

Prof. Bell was not present, but Prof. Gray, who was regarded as one of the most important persons in the dispute, was in attendance all day, and lawyers who are not engaged in the present proceeding, but have been and are still interested in other suits against the American Bell Telephone Company, were there, conspicuous among them being Mr. A. Q. Keasby, of Newark, N. J.

Col. Gantt, Col. Young, Mr. Humphreys and Mr. Beckwith renewed the assault upon the "telephone monopoly" with dozens of affidavits from university professors and high scientific authorities in Germany, telling of lectures delivered at Frankfort-on-the Main, and at other places in Germany as early as 1860, and continuously for years afterward, by Prof. Philipp Reis on his invention, which he called the telephone, for transmitting articulate speech. Not only did counsel submit affidavits of those who saw the telephone in operation and actually conversed over it, but numerous extracts from German newspapers, scientific periodicals and books printed twenty years ago were produced, containing reports of Reis's inventions and experiments, which it was contended showed that the art of transmitting articulate speech over a wire by electricity was a matter of public knowledge at that time. Prof. William J. Green, electrician at the Smithsonian Institution in Washington, testified that he made an exact copy from one of the original Reis telephones, received in the institution in 1874, and that it transmits articulate speech perfectly.

The following ingeniously ambiguous affidavit was put in from Thomas A. Edison:

I reside in New York. I am 38 years of age and am by occupation an inventor. I am the Thomas A. Edison, the patentee mentioned in the English patent of July 30, 1877, No. 20909, for a telephone. The inventions described and stated in that patent were made by me in 1875, the experiments continuing from that time right along, and culminating in the carbon telephone now universally employed. The transmitting telephones now used by the American Bell Telephone Company employ that invention. The dates of some of my patents are, as I verily believe, stamped upon their transmitters. I had no knowledge of Bell's inventions in speaking telephones when I made that invention. I had no knowledge of the Reis publications at that time.

A copy of a book entitled "Philipp Reis, the Inventor of the Telephone," written and compiled by Silvanus P. Thompson, professor of experimental physics in University College, at Bristol, England, was put in evidence, containing many communications from scientific men, contemporaries of Reis and witnesses of his work, which the author of the book collected and published about two years ago—all these documents and sworn affidavits of living men constituting, as Col. Gantt contended, a powerful body of contemporaneous testimony, which, unless it can be overthrown, puts the question of the invention of the telephone beyond controversy.

The petitioners put in another affidavit of Z. F. Wilber, the examiner in the patent office who examined Bell's application, to the effect that he was now of the opinion that the law was infringed by the patent office in giving Bell information which ought not to have been given to him about Prof. Gray's application for a caveat filed on the same day as Bell's application for a patent.

The petitioners reserved their heaviest gun for the last assault. Before resting their case they introduced an affidavit made by Prof. Elisha Gray, of Chicago, before G. A. Armes, a notary public for the District of Columbia, the 9th instant. The affidavit, which was read by Col. Young, contains matter that is likely to bring about an important controversy, and we have therefore thought best to reprint it in full. It is as follows:

AFFIDAVIT OF PROFESSOR ELISHA GRAY.

I. Having received from the government a number of patents which were supposed, among other things, to relate to telephony, I made a conveyance of the same to the Harmonic company in the year 1876. In consideration of that conveyance I received a stock interest in the said company.

II. This company conveyed to the American Speaking Telephone Company all its right, title and interest in said patents, so far as they related or might relate to speaking telephones. The Harmonic company received, in consideration of said conveyance, one-third of the stock of the American Speaking Telephone Company. My interest in this stock was owned jointly and equally by myself and Dr. White of Philadelphia.

III. The American Speaking Telephone Company, the Harmonic Telegraph Company, the Gold and Stock Telegraph Company, and the Western Union Telegraph Company, were the real defendants in the suit of the American Bell Telephone Company, commonly known as the Dowd case. Some time after the institution of this suit, a compromise was effected between the complainant and the defendants, by which the complainant company and the defendant companies jointly owned all the patent rights involved, the American Speaking Telephone Company receiving in said compromise twenty per cent. of the royalty received upon all the patents owned by the said companies. It was also to be interested in future patents that might be acquired by the combination, and was to contribute its proportion of the purchase-money expended in acquiring such new patents. From that time forward the said company was also to pay its part of any litigation that the combination might be involved in. Soon after the beginning of the Dowd suit, the subject of a compromise was suggested, and before finally consummated it was generally understood that a compromise would be effected; that the parties in interest could probably make more by a compromise and by owning the patent rights of the several companies as common property, than could be made otherwise, and that such a settlement especially was better than the hazards of the ultimate result of the litigation. Before said combination was effected, and after it was substantially understood that a settlement would be made, it is my belief now the litigation was not carried on energetically and in strict good faith with the view of an arms-length litigation and a final settlement by the court. This resulted from the fact that a determination by compromise was looked to by the several parties in interest.

IV. After this settlement, the property being owned by the complainant and the defendants in the proportion agreed upon, there was of course, as I suppose now, no such thing as litigation in good faith, but from that time everything was done for the common benefit of the complainant and the defendants, and such decree was entered in the case as they desired, the whole being conducted in such manner as to subserve the common interest.

V. I had no control over this case at any time. The corporation in which I was interested as a stockholder represented such interest as I had. After the terms of settlement were agreed upon, then the interest being common, the cause was carried on to a conclusion in a way to promote the common interest.

VI. I was the inventor of an electric speaking telephone. I described that invention in a caveat which I filed on the 14th day of February, 1876. I afterwards learned that on the same day Professor Bell filed an application for an improvement in multiple telegraphy. I learned, but not until after his patent on said application was issued, that in the said application he claimed to have discovered and invented an electric speaking telephone. Not long after my caveat was filed I received notice that an application had been filed that in some way conflicted with it, and that I must prepare an application on my caveat with a view of declaring an interference on account of said conflict. Soon after this I learned that the interference had been dissolved. I did not then know that the supposed conflict was between my caveat and the said application of said Bell. In March, 1876, a patent issued to said Bell upon his said application. I am informed and believe that a few days after the issuance of said patent said Bell made an instrument with which he transmitted articulate speech. Long afterwards I learned that the instrument with which he first transmitted articulate speech was a liquid transmitter, and substantially the same as that described in my caveat, but wholly unlike anything described in the said application and patent of said Bell. I believed, and remained under that belief for a long time, that said Bell actually invented the instrument with which he thus first transmitted articulate speech. I then believed that he and I were both aiming at the same end, and that each, without knowing what the other was doing, had discovered and invented a speaking telephone. At the Centennial Mr. Bell exhibited a telephone which transmitted articulate speech. I witnessed the exhibition. He did not use a liquid transmitter on this occasion but used an instrument very nearly resembling the receiver of my invention. I communicated this fact to my counsel and requested his opinion as to how my case stood in view of said fact. He informed me that practically my claim was defeated, that Bell's application was filed the same day as my caveat, and that Bell having made an instrument that successfully transmitted articulate speech, he occupied a better position and would undoubtedly succeed. I then did not for a moment suspect anything wrong, but supposed that in the eye of the law Bell had, as my counsel advised me, the advantage. Every oral statement made by me on the subject, and every letter written by me, which in any way indicated that I regarded said Bell as the original inventor of the telephone, with probable priority in the eye of the law over my discovery, were made and written under the belief then entertained as to perfectly fair dealing with regard to my caveat. Recently and long since the oral statements were made and the letters referred to were written, and long since I gave my deposition in the Dowd case and in the interference cases in the patent office, facts came to my knowledge that convinced me that I was wrong in assuming and believing that Professor Bell had fairly made his invention. But I now believe that he, on the contrary, had learned in some way of my caveat and of its contents; that he made use of that knowledge in constructing the instrument with which he first successfully transmitted articulate speech. I supposed my discovery remained a secret in the patent office, as it should have done, and was not known to Mr. Bell at the time he made his first successful transmission of speech. What I now state on the subject is made in view of this information which satisfies me that Mr. Bell, having obtained my secrets, claimed my discovery as his own, and by this means got the credit of my invention. Acting, however, at the time under the belief of his fairness in the matter, and advice of my counsel as to my rights, as before explained, I made such statement and gave said depositions.

VII. Being under this belief I did not take steps to file my application upon my caveat promptly, but the matter rested without any application until November, 1877. This long delay will be understood in view of what I have already stated. Some time prior, however, to the filing of said application, it was suggested by the American Speaking Telephone Company, under the idea that it was the owner of said caveat, that an application had better be filed any way for a patent upon the caveat, that some advantage or benefit might be derived from it. I accordingly filed my application. This was my act thus done and done by my counsel at the request of said company, but before any further steps were taken under said application, except to declare an interference between my application and the Bell patent, the compromise had been effected between the contestants in the Dowd case, and acting under the belief which I then entertained that by conveyance the American Speaking Telephone Company was the owner of said application and said caveat, and the rights therein mentioned, and believing that these rights had become the common property of the complainant and defendants in the Dowd case compromise, believing that whatever interest I had was only as a stockholder in the American Speaking Telephone Company, and that under that compromise I had no longer any financial interest in pressing the interference suit, nor had the American Speaking Telephone Company, as it was immaterial how that contest was terminated, provided it was done in such a way as to subserve what was believed to be the common interest of this combination. After the combination, and without any action on my part, the said interference suit growing out of my caveat and the application thereon was again set in motion and conducted to a result. I was examined as a witness in the interference suit, my deposition being taken in the city of Chicago. I had no counsel employed, however, and took no interest in it, and only gave my deposition when called upon by the combination referred to. These companies, as they believed, and so did I at the time, held and owned all the patents and all the claims in said interference case and the other interference cases that were carried along with these, and although there appeared to be opposing counsel and a struggle and a contest, and much proof was taken, deponent verily believes that there was really no struggle and no contest, and that it was intended to carry these interference cases on and bring out the final result in such a way as best to subserve the interests of the combination made up by these three corporations. By looking at the record of these cases, it appears that I had counsel; that I was a litigant actually contesting this matter, and asserting or attempting to assert the priority of my discovery over that of Prof. Bell's, and the other alleged discoverers and inventors that were made parties to the same controversy. Such was not the fact, however. I had no counsel, I was not a litigant; the whole apparent discovery was, as I now believe, collusive, and carried on with the appearance of an array of opposing counsel, that these counsel all understood each other, and were working for a common end agreed upon beforehand by the combination. It was supposed, as I have lately been informed, that these interference suits thus carried on and worked out would strengthen the claims of the corporations that were engaged in carrying them on in their interest. I was not consulted except to give my depositions, which I did when called upon, and did render them in the honest belief that Mr. Bell had the advantage which I have already mentioned as explained to me by counsel. The counsel named in the record as representing me in the said interference suit were paid, as I understand, by the said combination, consisting of the parties complainant and the parties interested in the Dowd case, in pursuance of their agreement and understanding all the litigation carried on for their joint benefit was to be paid for by the combination. Not only was this the case, but one of my counsel, so called, was at some time—the precise time I am unable to state—retained for the American Bell Telephone Company, and is now in its employment, as I learned some time since when speaking to that counsel with the view of a proposed employment which might conflict with the interests of said company. It is not a fact that the result in the Dowd case was reached by a trial

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upon the merits and a decision according to the merits, but it was reached by the agreement and understanding of the parties in interest. Nor is it a fact, as I believe, that the interference suits were carried on upon their merits in a real *bona fide* controversy, but on the contrary I believe that said interference litigation, although seemingly hostile, was really friendly, and the result reached was not a decision upon the merits in a hostile controversy, but in a collusive controversy, in which the only parties interested were the parties in interest in the Dowd litigation.

VIII.—The stock which Dr. White and myself received for our interest in the sale to the American Speaking Telephone Co., for the patents embraced in that sale, all went to Dr. White, as by our contract he had a lien upon my half for debts which I owed him, and my half was absorbed in the payment of these debts. I subsequently bought stock, and by speculating in it made something.

IX.—In some correspondence that passed between Prof. Bell and myself in the year 1877, I accorded to him credit as an actual discoverer and inventor, which was done, however, under the belief that he was entitled to priority, and that without any knowledge of my caveat he really had been enabled to appear to be a discoverer and inventor, when such was not the fact, as I now verily and truly believe. I also wrote them under the belief and advice of my counsel that by reason of his claiming to have filed his application before my caveat, and of his practical demonstration with an electric speaking telephone, made according to my discovery, but which I then supposed was made according to his own independent discovery, that therefore, in the eye of the law, his claim would take rank over mine. About the same time that said correspondence took place I delivered a lecture in the city of Chicago, when I exhibited the instrument claimed by Prof. Bell as his invention. In order that the matter may be properly understood it must be borne in mind that the letter in which it is claimed that I gave Prof. Bell credit as an original inventor was written long before I knew that his first transmission of articulate speech was with a liquid transmitter like that described in my caveat, and that at the time of writing said letter and giving the lecture I only knew of the transmission of speech made at the Centennial with an instrument made like my receiver, which I had never used as a transmitter.

X.—The opening and concluding arguments of the counsel who nominally represented me in the interference case, but really representing the said combination, and in whose employment he then was in said interference suit, conceded the discovery of the broad art to Mr. Bell, claiming for me only a device or improvement on the art which Mr. Bell was conceded to have discovered. I did not know until long after that such was the case, but it plainly appears on an inspection of these arguments which I have lately made. These arguments, however, are in harmony with the intent of the combination and to carry out its purpose in these collusive and simulated contests.

XI.—The combination claimed my caveat and all the rights thereunder by virtue of my conveyance to the Harmonic Telegraph Company. I did not intend to convey it, but I labored under the belief that I had been overreached, or by mistake had conveyed more than was in contemplation when the trade was made. After being informed that I had been wronged in the patent office touching my caveat, either by design in disclosing my secrets or by remissness or accident, and that it was my discovery with which Prof. Bell first transmitted speech soon after my caveat was filed, as I am informed, and believing that he has learned my secret, I concluded that I would have the said conveyance examined by counsel, which I did, and was advised that my said conveyance did not cover the caveat, but only certain specific patents then granted, and which it was supposed by the purchasers related, among other things, to telephony, and which patents they believed, although not granted expressly in reference to that art, yet embraced the principles that might be controlling in contests touching it. I was misled by the assumption on the part of said company and its assignees that said contract covered said caveat, and I labored under this mistake until I had the contract examined as above stated.

After the conclusion of the reading of Prof. Gray's affidavit, Mr. Young read a letter from himself to the counsel of the Bell company, calling for the production of contracts alleged to have been made between the Bell company and Elisha Gray, the Gold and Stock and Western Union Telegraph companies, Messrs. Blake, Berliner and others. In his letter Mr. Young explained that he wished to establish by these contracts that the alleged telephone inventions of Bell were invalid; that the Dowd suit was inconclusive, and was only brought to obtain a judicial decree sustaining the patents; and that Bell and his associates entered into an unlawful combination to control all telephonic discoveries. In answer to Commissioner Montgomery, Mr. Young said that he expected the counsel for the Bell company to produce the papers on the following day. If they failed to do so, he would endeavor to introduce testimony showing the nature of the papers required.

THE RESPONDENTS PRESENT THEIR CASE.

Mr. Storrow, in presenting the case in behalf of the respondents, said that he had caused the bill of the Memphis petitioners to be reprinted in order to get at their allegations with technical accuracy. He said that the affidavits read for the most part were not affidavits produced here, or even copies of papers sworn to for this purpose, but were mere copies from the records in former suits, which resulted in decrees by the courts in favor of the respondents. Handing to the secretary copies of the moving papers in the Baltimore case against the Pan-Electric company, he called attention to certain letters written by Bell a year, more or less, before the patent issued, stating that he was then at work inventing the speaking telephone, and showing that that was his controlling thought. An affidavit from Mr. Watson, Bell's assistant, relates how the telephone was offered to and received by the public, and how it went into commercial use, and by long extracts from contemporary publications shows that Bell's telephone in 1876 was received as an absolute novelty, with the general consent of mankind that nothing of the sort had ever been known to the world before; that the first telephone line for any useful purpose in the world was equipped by Bell in Boston in the spring of 1877. Watson relates the rapidity with which the invention was introduced, until in six or eight years there were 300,000 instruments in use in this country alone, not to mention the rest of the civilized world. Mr. Bell exhibited at the centennial exhibition two forms of speaking telephones, one known as the liquid transmitter and the other as the magneto transmitter. Mr. Storrow then explained the construction of the telephone used at the centennial, which is familiar and need not be repeated, and showed how a correspondence between aerial waves caused by the utterance of a given word and the electric waves in the conductor is the prime essential for transmitting speech. Mr. Bell's apparatus produced and utilized just that correspondence; and was the first which had ever done so. That is exactly what is expressed by his invention in the fifth claim of his patent. Mr. Storrow then referred to the exhibition of the magneto transmitter and receiver at the centennial for the first time June 25, 1876. The exhibition was arranged primarily to enable Mr. Elisha Gray to show his harmonic multiple telegraph. There were present the Emperor of Brazil, the judges, of whom Professor Joseph Henry was chairman, Professor Barker, and about 75 persons altogether. After Mr. Gray had completed his exhibition of his harmonic telegraph, Mr. Bell asked permission to exhibit something which he had. He produced his speaking telephone and they talked through it. The Emperor of Brazil listened and repeated to the audience what he heard, and so also did Sir William Thomson. Elisha Gray was present; he listened at the instrument and repeated to the audience what he heard and they cheered, and he testified in his deposition in the Dowd case that it was the first time in his life that he ever even listened at a telephone receiver. The report of Professor Henry, chairman of the committee, declared that the apparatus was "the greatest marvel hitherto achieved by the electric telegraph," at least a prima facie assurance that in 1876 a speaking telephone was a marvel and a novelty.

The affidavit of W. C. Tompkins states summarily the litigation with reference to the Bell patent, and gives extracts from the opinions of the courts sustaining the patent upon every occasion. The affidavit of Mr. George Gifford, now deceased, counsel for the Western Union Telegraph Company in the Dowd case, stated what the settlement of that case was, and how it came to be made. Mr. Storrow said that the courts before whom this affidavit had been presented had said in effect that the opinion of Mr. Gifford that his clients could find no defense to the Bell patent, and that he was satisfied that Bell was the first inventor of the telephone, was very persuasive. Mr. Gifford's affidavit concludes as follows: "This settlement never would have been advised by me if I had not believed, upon the record or through the facts which I could ascertain, that the Bell patent was valid and that all microphones and carbon transmitters, as far as I knew or could ascertain, infringed it." Mr. Storrow said that it would appear elsewhere that before the negotiations for a settlement were commenced, the evidence in the Dowd case had been taken and printed.

Handing to the secretary a printed book containing the opinions of the courts and the patent office, Mr. Storrow referred to the opinion of commissioner Paine, the examiner of interferences and of the board of appeals, which commissioner Butterworth in his opinion sustained. He explained the points at issue in the different telephone interferences; the first one for example raised the question "who was the first inventor of the speaking telephone in the broadest sense;" the next, "who was the first inventor of one particular way of transmitting speech, to-wit: by means of a variable resistance transmitter," and so on as to the various forms and details of the invention. The final decision of the commissioner gave to Bell every issue in which he was involved.

In reply to a question from the commissioner of patents Mr. Storrow said that Gray was a party, and was decided against as to all his claims by the examiner of interferences. He did not appeal on the broad claims but only on the issues that concerned the broad construction of the receiver. Mr. Storrow then submitted the affidavits of Mr. Bell, and of Messrs. Pollok and Bailey, the solicitors who obtained his patents. These affidavits explicitly denied all fraud, contrivance or concealment, or any fact tending to show the same, and stated fairly and fully what the facts were. An important affidavit from ex-examiner Z. F. Wilber was then submitted. Mr. Storrow said that after making the affidavit which had been read by Mr. Humphreys, in which Wilber stated that when he passed upon the Bell application he had no sort of an idea or suspicion that it contained a speaking telephone, he had made another affidavit, the one now submitted. The most material statements in it are as follows:

As I have elsewhere testified, and as appears by the record in the case, on the 29th of February, 1876, an amendment was filed by the attorneys for Mr. Bell, which amendment was incorporated into the case. Such amendment was made to more clearly set out the difference existing between the invention in this case and an invention of Mr. Bell's, set out in a prior pending application filed by him early in 1875. The amendment did this. It was made for such purpose and extended to such object only. It was not based upon the Gray caveat, had no relation thereto, and in no way interfered with or limited any rights of the caveator, over and above the application as originally filed. As I have elsewhere testified, this amendment was not sworn to. It was admitted thus unsworn to, because, in my opinion, it contained no new matter.

He states that he has carefully examined a copy of the Gray caveat interference notice and other proceedings, and says:

These things indicate to me that I *did* know that the Bell application was for a speaking telephone, for otherwise I could not have used the terms I did in notifying the caveator, and in fact could not have determined that the application and the caveat interfered, or were in conflict.

Mr. Storrow next showed from Mr. Gray's deposition in the

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Dowd record that he received the notice of interference, which he soon afterwards learned was with Bell's application, by a letter from his attorney, Mr. Baldwin, and also a copy of Bell's patent the same month of its issue; that at the centennial when he listened at Bell's telephone he heard the nearest approximation that he had ever heard to articulate speech, he repeated to the audience what he had heard, and they cheered; after listening to Bell's apparatus on June 25th, 1876, he then for the first time in the world undertook to make a speaking telephone, and was unsuccessful. He read also from the Dowd record a letter from Professor Gray to Professor Bell asking permission to explain and exhibit "*your* method of transmitting vocal sounds" in a lecture, mentioning that he himself had filed a description of a talking telegraph on the same day. In a lecture at New York he publicly stated that his (Gray's) telephone had been confounded with the speaking telephone invented by Professor A. Graham Bell, of Boston.

At this point proceedings were adjourned for the day and were resumed on Thursday, November 12, at 10 A. M.

Mr. Storrow continuing, put in the affidavit of Mr. Davidson, managing clerk of Messrs. Baldwin, Hopkins and Peyton, to show that the notices issued by the patent office in the prospective interference between Gray and Bell were in accordance with the usual practice of the office at that time.

Mr. Storrow then said he would read some evidence bearing directly upon the important question of alleged fraud. He read from the record of the Dowd case a letter of Professor Bell, dated March, 1875, giving an account of his interview with Professor Henry, and related how he had asked Professor Henry's advice about the apparatus which he had designed for the transmission of the human voice by telegraph, and the encouragement he had received from him, saying in conclusion that he believed it was feasible and that he had got the clue to the solution of the problem. Mr. Storrow said that in the Dowd case the precise question of the relations between Mr. Gray and Mr. Bell in the patent office had been raised, and was one of the chief foundations of the defense, in verification of which he read a long extract from the amended answer to the complaint. He then read from Bell's deposition in the Dowd case giving an account of his interview with the examiner in regard to the prospective interference; that the examiner said, "it is a caveat. I cannot show it to you," but that he (the examiner) took up Bell's application, then pending in the office as originally filed, pointed out a certain passage in Bell's own application, and said "it is something on that page that the caveat interferes with." Could there be a straighter statement that the common matter in interference was already in Mr. Bell's papers? He then read from testimony of Mr. Gray, and of his confidential assistant, Mr. Goodrich, in the same case. Mr. Gray testified that the invention described in his caveat was suggested to him by seeing a lover's telephone on the street; that his first definite notion communicated to any one was on the 11th of February, 1876. This was the first date tending to show any conception in his mind. No date of invention for him can by any legal possibility go back of that. He (Gray) gave a sketch to Goodrich and told him to have Mr. Baldwin's draughtsman put it in shape and he would file a caveat on it, which he did on February 14th. A letter written by Gray to Bell before the controversy began in 1877, shows that he already knew that his caveat was filed some hours later than Bell's application. Several letters which passed between Mr. Gray and his solicitor, William D. Baldwin, of Washington, were put in, the most important one being that dated March 3, 1876, from Baldwin to Gray's partner, Dr. S. S. White, of Philadelphia, which has been already given in Gray's affidavit, and for lack of space is not reprinted here. Gray took no steps to contest the application even after a copy of Bell's patent had been sent him. At the centennial Gray listened to Bell's instrument, and while the audience cheered, and such men as Professor Henry and Sir William Thomson were filled with admiration, Gray was disposed to sneer at the thing as a trick or a toy. He tried to make an instrument according to his caveat; it would not talk, and he sneered the more. November 1, 1876, when Bell had already become famous, Gray wrote Baldwin: "As to Bell's talking telephone it only creates interest in scientific circles, and as a scientific toy it is beautiful, but of no commercial value." By the next year he began to think that the "toy" might bring fame and fortune. He still knew that he had done nothing, but wanted to keep alive such ground of pretention as he had, and wrote to Mr. Baldwin that he would like to keep the caveat alive. Next arose the contest between the Bell company and the Western Union which had acquired all of Mr. Gray's rights, claims and pretensions; at least he thought he had sold them and they thought they had bought them, and he got his pay, but now hopes to pick a flaw in the deeds. In the midst of the Dowd suit, June 5 1879, Baldwin wrote to Gray that he gathered from Bell's preliminary statement that Bell "had no success until he adopted the devices shown in your caveat after the grant of his first patent." Even with this knowledge the Western Union party decided that it was impossible to beat the Bell patent, and therefore made the settlement described in Mr. Gifford's affidavit. Beside the adjustment of pecuniary interests between the corporations, there were questions what patents ought to issue under various conflicting applications, in which the respective inventors might well have a personal interest of pride and of pocket. Thereupon Baldwin wrote Gray November 3, 1879, "You have personal rights in this matter which in my opinion can only be properly settled by the adjudication of the patent office. * * * My notion is to speed the cause and simplify the issue by letting each party disclaim what it cannot contest successfully and confine himself to the points to which he is entitled." Thereupon the parties so agreed in their contract of November 10, 1879, adopting the *rights of the inventors* as the basis. No one was so much interested as the two contracting parties that in order to insure the validity of the patents, the first and true inventor should receive them in each case. Moreover the Bell patent was then four years old; if a new patent could be got for Gray it would extend the monopoly four years. The question was submitted to the patent office, and the interferences were prosecuted to their ultimate decision. While the expenses were expected to come out of the profits of the telephone yet the contest was similar to one where the cost of both sides, as in contesting the validity of a will or the distribution of a fund, comes out of an estate. In November 1881, the interferences were argued before the examiner. Mr. Baldwin made his case on the plan indicated. In his printed brief, he stated that the evidence in the Dowd case had satisfied the parties that the Bell patent was unassailable; that Gray was not the first inventor, and that therefore he retired from the contest on the broad claim to the transmission of speech, but he nevertheless insisted that Gray had invented the receiver a year before Bell. October 29, 1881 he sent Gray a copy of the brief containing this position in terms. Gray replied that the brief was a very able document which Baldwin should be proud of, and asked for additional copies which were sent. The decision of the examiner was against him. Baldwin advised him, August 3, 1883, to appeal on the receiver cases and let the rest go. Gray made no suggestion to the contrary, and Baldwin took that course sending copies of his argument to Gray December 18. The case was decided against him in the fall of 1884. November 6 he wrote to Gray that he should appeal to the commissioner, which he did and was again defeated. He and Gray corresponded about it both expressing great dissatisfaction, and Baldwin suggested an appeal to the courts to reverse the commissioner's decision. To all this Baldwin says Gray never made any objection, and never expressed any dissatisfaction, but quite the contrary.

Mr. Storrow then took up the matter of Antonio Meucci. Referring first to Mr. Lockwood's affidavit, the latter says that the defense that Meucci was the first inventor was set up in 1880 in the Spencer case, and in many subsequent cases, and the whole story was printed more than a year ago in the London *Electrical Review*. The caveat of Meucci, which must be conclusively deemed to contain the best he knew on the subject, does not, according to the affidavits of Messrs. Lockwood and Pope, describe an electric telephone at all, but merely a mechanical telephone with a notion that the effect can be increased by electrifying the operators—the silly notion of a crank. The affidavits in Meucci's behalf were an effort to show that in 1864 he had a perfect telephone, but was absolutely too poor to apply for a patent. His poverty is sworn to over and over again. One man, Dendi, swears that during all these years, he knew that the friends of Meucci would not help him procure a patent for the speaking telephone or any other invention, and would only give him the necessaries of life. May it please your Honors, Dendi and Meucci took out a patent as joint inventors two years ago. During the time when Meucci was so poor that he could not take out a patent for his speaking telephone, we find him *eighteen times* at the patent office, taking out over a dozen patents, to say nothing of other applications which have been rejected. Mr. Storrow submitted copies of more than a dozen patents taken out by Meucci, one of them, dated January 21, 1872, for "effervescent drinks;" one dated August 26, 1873, for "sauces for food;" one dated September 28, 1875, for a "lactometer:" and one dated October 10, 1876, for a "hygrometer." In fact, Meucci seems to be a prolific inventor. His first patent was issued to him in 1859 and the last one in 1883.

Mr. Storrow next referred to Prof. Eaton, who, he said, had made a curious affidavit, charging in substance that his own counsel in the Spencer case betrayed him. To meet that, his counsel, Mr. Betts and Mr. West, of New York, and his expert, Prof. Henry Morton, had been applied to, and their affidavits are now presented. Mr. Betts and Prof. Morton both say that they did their utmost to defend the case to the very best of their ability. Their affidavits were express and explicit to these two facts, that the defense in that case was that the Reis was a speaking telephone, that they did their best to get speech with a true apparatus—not a bogus one—but in vain; and they could get nothing from Eaton that would help them. They examined the Meucci case and his affidavits, and Mr. Betts concluded that there was nothing in the story fit to spread before a court. Two months ago Prof. Eaton's testimony was taken in the Overland case, when he said that in 1875 he tried to transmit speech with the Reis and could not do it. Mr. Storrow said that in fairness to Prof. Eaton it should be stated that he does not make a charge of unfaithfulness against his counsel; this was insinuated in an un-

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sworn draft of an affidavit left here ten days ago, but he would not say it, for the charge is not found in the affidavit actually filed; it comes only from Meucci's counsel. Mr. Storrow then referred to the record of former cases, saying that more than nine-tenths of the evidence produced by the petitioners consists, not of affidavits, but of copies of affidavits taken last spring, and filed in the Pittsburg court as a defense to the motion on this patent against the Pennsylvania Telephone Company, and which were found by the court totally insufficient to defeat an injunction. To make a new case they can do no better than to copy an old one. He desired their honors to note that they were now called upon to hold an appeal from the decision of the circuit court of Pittsburg against this same apparatus, upon essentially the same evidence, printed copies of affidavits cut out of the printed book of the Pittsburg case, and submitted here with an affidavit of one of the parties that they are true copies. The instruments presented were also made for the Pittsburg case, and presented there.

Referring to the affidavit of Prof. Dolbear, and the appended letters, especially one from Prof. Dolbear's assistant, Mr. Buck, Mr. Storrow said that the instrument had been got in Germany, and put in evidence for the defense in the Dolbear suit in Boston. They swore that it would transmit speech, no trouble about it. They were asked to do it again in the presence of witnesses; they set up the apparatus and found that with the Reis transmitter and the Bell receiver they got speech; and with the modern carbon microphone and the Reis receiver they got speech, but that was not the Reis instrument at all. When they took *fac-similes* of the Reis instrument from Germany and coupled them up, Prof. Dolbear said he heard in the course of ten or fifteen minutes' trial *eight words*, it was found, when compared with what had been spoken at the other end, that *four* of these supposed words had never been spoken. Two days afterwards it was tried again with no better result. Judge Lowell, in deciding the case, said that Mr. Dolbear, in a book published in 1877, declared that it was an impossibility to transmit speech by the method or instrument of Reis. He now endeavors to assert a different view, but the experiments tried fôr the purpose in the presence of counsel were a signal failure. Referring to an article in the *Manufacturer and Builder* of 1869, written by Dr Van der Weyde, as showing the publicity of his invention, Mr. Storrow said that his express language in that article is that it is impossible to transmit speech by the instrument now set up as a speaking telephone. He would show, by comparing the Reis publications with the instruments produced by the petitioners, that the latter were not in any sense reproductions; that they have introduced features employed in the Blake transmitter for the very purpose of avoiding the action described by Reis. This matter was fully gone into at Pittsburg and the alleged reproductions condemned. The nature of the litigation at Pittsburg was then explained, the substance of the statement being that by agreement of counsel in that case it will go to a final hearing within a month, and be certified to the supreme court in order that it may be decided at the same time with another case now on the docket of that court, involving the validity of the Bell patent, and which, it is expected, will be decided at the present term.

Mr. Storrow then referred to the matter of contracts, and ridiculed the demand of the other side for the production by the Bell company of certain contracts to which it is not a party, and copies of most of which are not to be found in printed records. He said that Cushman's attorney had applied to his associate, Mr. Smith, two weeks ago, and proposed to take pay for suppressing the affidavits here presented. He wished also to state that so far as suppressing Cushman's knowledge was concerned, it could be proved that he published the whole story in the newspapers in 1881 or 1882, and again this year, that he told his story to the patent office in 1881, and that it is now on file there.

At this point the hearing was adjourned for the day and was resumed the next morning at 10 A. M.

Mr. Beckwith, counsel for the National Improved Telephone Co., stated that he was present during the Pittsburg trial only as a spectator, and had no pecuniary interest therein. But as a spectator his recollection differed materially from the statement made by Mr. Storrow yesterday. In that trial Mr. Storrow made a full exposition of his case, but before the defendants had an opportunity to reply the judge applied the judicial tourniquet, and said that on account of judicial courtesy and the courtesy which should be observed between judges of different circuits he would not consider the question of legality or construction of Bell's patent open for discussion on an application for a preliminary injunction, and that unless there was in the instrument used by the defendant something in construction that carried it out of similarity with the instruments proceeded against, then for the purpose of a preliminary injunction the matter was settled. As considerable importance was attached to that point by the other side he presented affidavits tending to establish the facts as he remembered them.

Mr. Young inquired of Mr. Storrow if the Bell company had not brought suit against the National Improved Telephone Co. in New Orleans and against the Globe company in New York since the commencement of this hearing. Mr. Storrow replied that the attorneys had been directed to bring the New Orleans suit long before the beginning of the present proceedings. In the case of the Globe company, it had been known for several years that such a company existed, but until a very short time past they had never offered to use instruments or take any step that would admit of the beginning of a suit by the Bell company. Within a few days, however, circulars issued by the Globe company had been discovered that furnished the necessary evidence for the institution of a suit. Mr. Young put in evidence affidavits of Prof. Waite and Prof. Paddock containing accounts of experiments made by them with the Reis and Bell telephones.

In answer to Mr. Young, Mr. Storrow declined to produce the contracts called for by the defense on Tuesday last, unless the secretary should signify a desire to have them produced. Upon an intimation from the secretary that he would like to see the papers Mr. Storrow agreed to produce them. Mr. Humphreys wished to have included in the records the patents of Hughes, Edison, and others, and various file wrappers and papers from the patent office records, and the evidence was duly admitted. He also read an affidavit by president Goodwin of the Globe company, testifying to Meucci's extreme poverty; that Meucci was oppressed by the American Bell Telephone Co., through the institution of a suit against him, and that the Bell company, through its attorney, had endeavored to purchase and acquire the claims of Meucci

Mr. Storrow—Who was that attorney?

Mr. Humphreys—We will point him out. You can name him.

Mr. Storrow—Who is he?

President Goodwin, of the Globe company, rose and pointed to a gentleman in the room. Mr. Storrow smiled, but did not offer to name the gentleman. Mr. Dickerson, however, stated that the gentleman was Mr. Tompkins.

Mr. Humphreys—I would like to ask whether he is the same Mr. Tompkins who managed the Eaton case for Spencer.

Mr. Dickerson—No, Sir. He has a different name and is a different person.

Mr. Storrow then replied briefly to the affidavits. He said that he had put in a sworn stenographic report of the Pittsburg trial. In answer to the allegation that the Bell company had attempted to buy Meucci's claims, he said that he could produce letters to show that the Bell company had been invited to go to Philadelphia to negotiate with the Globe company, and that they had sent down a representative, but the Meucci people had declined to show him anything, and he returned no wiser than he went.

Mr. Beckwith inquired if he would be permitted to put in a counter affidavit, sworn to by five gentlemen, to the effect that no such invitation had been extended by the Globe company; that the Bell representative had called upon Mr. Goodwin and associates and spoken of millions of money, and that the gentlemen representing the Globe company had drawn their watches and given the Bell representative 20 minutes to leave.

In answer to an inquiry by the secretary, Mr. Gantt said that if it was deemed desirable the petitioners would cause tests to be made of the workings of the various models submitted in evidence. If the other side assailed their testimony as to the workings of the models he would like to put in expert testimony in answer. The secretary expressed a preference for affidavits rather than oral expert testimony, which he said always had the effect of stampeding him.

Mr. Storrow expressed a wish to put in an affidavit by an expert. Touching this line of procedure the secretary said that the case would resolve itself into a question of expert testimony, and no doubt both sides could produce evidence to sustain their respective cases.

The counsel for the Bell company expressed a desire to examine and test the models submitted by the other side, and a long discussion took place between the opposing counsel as to the custody of the models. The secretary rather impatiently desired the gentlemen to come to an agreement; if they could not do that he would require the models to be examined in his presence. He explained that he was much pressed by official matters; another important case would come up for argument on Monday, and the case should be settled by that time. He believed that three hours ought to suffice for the presentation of each side—three for the petitioners as a unit, and three for the Bell company. The counsel expressed much discontent at this ruling. Mr. Young said that the case had assumed an importance far greater than he had contemplated when it began. Mr. Storrow said that the counsel had consulted together and regarded it as utterly impossible to make arguments in three hours. There were other issues here beyond the mere question of priority of invention. Charges of corrupt practice and fraud had been made and they require some attention. Finally the secretary decided to allow the Bell representatives two hours to prepare expert affidavits. The other side would be allowed a sufficient time to reply and the arguments must begin to-morrow. He begged the petitioners to condense their arguments into as short a time as was consistent with a proper presentation of their case.

The expert, Mr. F. L. Pope, of New York, finally examined the machines, and his affidavit was filed subsequently, in which

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he states that the machines in evidence are the original Reis machines, with the addition of certain improvements which have been patented and are used to form the Blake transmitter.

When the hearing was resumed Mr. Bakewell, who was of counsel for the defense in the Pittsburg case, made a statement touching the proceedings in that case. He said the court had declined to go into the question of the validity of the Bell patent. Mr. Bakewell had offered to prove that the Reis instrument would transmit speech, and the court said if that could be shown he would refuse the injunction, but, on second thought, said that that point would make no difference, and the question of practicability of the Reis instruments was not discussed. The instruments were not explained to the court or looked at, except in a casual way.

Mr. Dickerson pointed out that Mr. Bakewell's statement placed the Pittsburg court in a very disagreeable light. He appealed to Mr. Bakewell to recall the facts, and try and remember whether Judge McKennan had not said that if Mr. Storrow would acknowledge that the Reis telephone would transmit speech then he would deny the injunction, and that Mr. Storrow had declined to make any such admission. Mr. Bakewell admitted that some such statement had been made, but said it referred to another occasion, and he persisted in his first statement.

The hearing was then adjourned, and was resumed on the following day at 10 A. M.

Mr. Storrow, for the respondent said, that he desired to submit a modern Blake transmitter as a sample, a correct reproduction of the Reis-Legat transmitter which has been in the patent office for several years, filed by Prof. Morton (an opposing witness in the Spencer case),and the patent of Blake. He also desired to submit additional affidavits. He then read a strong affidavit from Mr. Baldwin, who has been Professor Gray's counsel for years, in which he traversed most of the statements contained in the affidavit of Professor Gray in the present proceeding, and declared that Gray had never before intimated any dissatisfaction regarding the manner in which his interests had been looked after by his counsel. The correspondence between Gray and Baldwin, was admitted by the secretary after he had asked Professor Gray, who was present, if he objected, to which the latter responded, that he did not, provided he was allowed an opportunity for explanation. The letters were then read, and went to show that Gray then admitted the priority of Bell's invention. Further affidavits were submitted by Mr. Storrow in regard to the Meucci patents and his ability to pay patent office fees.

Secretary Lamar consented to give the counsel on each side five hours for argument. Before the case was opened he said that he desired to receive as early in the argument as practicable some information on two or three points. One was as to what constitutes an invention to such an extent that it will preclude the granting of a patent for the same thing to another person; the second was a question respecting the present condition of the telephonic art, and the third a question as to what constitutes good cause for the cancelation of a patent which has been regularly issued by the government to an inventor.

THE ARGUMENTS OF COUNSEL.

The argument was commenced by Mr. D. Humphreys, of Cincinnati, counsel for the Globe Telephone Company.

Referring to Zenas F. Wilber, formerly examiner in the patent office, who has at various times made affidavits both for and against Bell, Mr. Humphreys said that whatever might be alleged against his habits and character he was the man to whom Bell owed his patent and all the wealth that flowed from it, and Bell's action in spurning Wilber from his door, as he had done a few days since, was without parallel in the history of man's ingratitude. The legality or illegality of Bell's method of obtaining from patent office officials the knowledge of Gray's invention, which enabled him a few days afterward to file an amended application embodying Gray's invention, had never been tested in a law court. If it should by any possibility be decided against the mass of evidence adduced that Professor Reis's instrument was not a perfect speaking instrument, the testimony of Professor Eaton showed, at all events, that whether or not any improvements had been added to make it speak, the Reis instrument, with or without improvements, was employed in Brooklyn in 1875 by the Professor and Mr. Pratt, of the *New York World*, in conveying speech from one to the other.

Bell's method of making inventions and obtaining patents, continued the counsel, was pretty well illustrated by the case of Professor Dolbear. In September, 1876, the professor had invented a telephone to work on the magneto plan. He talked with Mr. Richards, Bell's friend, about it, and was informed that Bell had invented and patented the same thing two years before. Dolbear did not then think of proceeding for a patent, but in January, 1877, following, Bell taking advantage of what Mr. Richards had learned from Dolbear, applied for and obtained his first patent for a magneto telephone.

Mr. Humphreys charged boldly that in the interference case before the patent office every one of the persons there represented was purchased by the Bell company; every one of the counsel, including Mr. Baldwin, a highly respectable gentleman, counsel for Professor Gray, he said, was paid by the Bell company; and every sentence of that voluminous record was paid for by the same company. In conclusion, Mr. Humphreys appealed for an order to institute the suit prayed for; an order to go to the very bottom of all claims, and mete out exact justice to all.

Mr. Casey Young, for the Pan Electric company, continued the argument, cited other cases in which the government had taken up the fight in the public interest against monopolies without title, and claimed that even if no more than a reasonable doubt as to the validity of a patent were presented it would be the duty of the government to take up the question and have a test made that would be final. The legal mind of the country, he said, was not satisfied with the rulings of the courts upon precedents that had been obtained by the sham litigation of friendly parties working for a common end. He referred to some of the statements published respecting the Memphis petition, in procuring which he declared, the Pan Electric company had taken no part whatever. The government he said, upon the petition of private citizens has the power to bring a suit to annul a patent in any proper case, and the Bell patent is invalid because it is too broad in terms, undertaking to cover the operation of a power of nature, because it possessed no utility, was issued irregularly and fraudulently,and was anticipated by prior inventions. It would require hours for him "to elaborate the discussion as justice to himself and the importance of the questions demanded."

After the noon recess Dr. Beckwith made a speech in behalf of the petition of Antonio Meucci, of Staten Island.

At the afternoon session of the court, when Mr. Storrow rose to open the argument for Bell, Professor Bell was seated directly behind his counsel with several members of his family, and the room was crowded and jammed with eager spectators more than at any other time since the beginning of the contest. Mr. Storrow, in discussing what the law regarded as an invention and sufficient to anticipate another claim, said that it was not sufficient that a man should have conceived the idea of a telephone and intended to produce it; nor that he should have published a description of an invention in which, with the light of a subsequent invention can be recognized a description of a telephone. The description should be such that a person without any invention on his own part could construct the instrument referred to and obtain from it the desired results without making any improvements or additions not contained in the description; it was not sufficient even to have produced an instrument that would sometimes produce a result and sometimes not. The question to be asked is, who gave to the world the telephone? In answer to this question, Mr. Storrow pointed to the centennial report, in which Prof. Joseph Henry, after having had Reis's instrument in his possession at the Smithsonian institute two years, declared that Bell's invention of a speaking telephone was the greatest marvel of the age.

Mr. Storrow then read a prospectus issued by the Washington Telephone Company, one of the contestants, last year, in which, discussing the marvelously rapid development and consequently great commercial value of the telephone, it is said that it was first exhibited at the Centennial Exposition in 1876, and that the first line for practical use was constructed in Boston in 1877.

The power of the government to proceed against a patent since issued, said Mr. Storrow, does not exist in this country. It never was adopted from the English common law, because the subject is covered by statute, and, therefore, the common law is excluded, and because the express terms of some of the statutes on the subject are against it. To revoke a land patent, counsel said, was quite a different thing, for in doing so the government acted simply as a landlord, and as any other landlord would. If Bell's patent was obtained by fraud, that is no reason for revoking the patent. When a man commits a crime we are not to proceed against him in equity and confiscate his property as a punishment instead of sending him to state's prison.

The history of this movement, said Mr. Storrow, is, that in 1883 a syndicate of gentlemen purchased from one Mr. J. H. Rogers some patents for changes of form in telephone instruments, which in themselves were of no commercial value. The Bell company could have them enjoined from using the telephone, but there was one thing they might do. If they could avoid or stave off litigation and injunctions by any means for a time, they could in the meantime send out telephones and make money, or if they could even make people believe that they had this power to stave off litigation they could sell their stock; so the syndicate metamorphosed into a corporation with a paper capital of five million dollars, and in May, 1884, the syndicate became the Pan Electric Telephone Co., and resolved to issue five millions of stock against the Rogers patents. The Washington and Baltimore is a branch of the Pan Electric. About the same time the National Improved Telephone Co., sprung into existence for the same purpose, and went into business with similar capital. That company too, gave birth to several branches in various parts of the country. Suits have been brought against them, several of which are still pending, and it is to prevent decisions being given in suits already brought that this movement has been started.

To the charge made by the petitioners that a telephone made

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according to Bell's specification would not talk, Mr. Storrow thought it was unnecessary to make any reply further than by referring to the affidavit of Prof. Nipher, one of the petitioners' own witnesses, stating that he had tried a Bell telephone made in exact accord with the specification and it did talk.

For lack of space we are obliged to omit the greater part of Mr. Storrow's masterly argument, as it is impossible to condense it, without doing it great injustice. We may be able to give it more fully hereafter.

The argument occupied the whole of an extra evening session. On Monday morning Nov. 17, at the opening of the session, Mr. Humphreys presented an affidavit sworn to by W. W. Goodwin, president of the Globe company, setting forth that in 1883 the American Bell Telephone Co., through its agents, did make overtures for the purchase of Meucci's claim to the invention of the telephone.

Accompanying the affidavits were letters and telegrams from the Bell company to the Globe company, arranging for an interview to discuss the proposed purchase. As an outcome of this correspondence Geo. M. Roberts, an attorney, and another gentleman, representing the Bell company, called upon a Globe official at Philadelphia, and one million dollars was mentioned as a sum to be considered in the negotiation. But the negotiation fell through.

Prof. Elisha Gray presented another affidavit and read it to the court himself. He said that in 1876, when his caveat was filed in the patent office, simultaneously with the filing of Bell's application for a patent, it was by advice of his counsel, Mr. Baldwin, that he refrained from a contest with Bell. His own caveat contained a full description of a perfect telephone, whereas he declared on his authority as an expert that an instrument made according to Bell's patent specification is incapable of transmitting speech, and the ordinary scientific knowledge of that time would not enable a man to construct a speaking telephone from Bell's description.

Mr. J. R. Beckwith made a very lengthy argument against Bell's patent, and estimated that Reis's publications of twenty years ago described a speaking telephone much more accurately and minutely than Bell's specification of 1876.

Mr. E. N. Dickerson replied for Bell, and, after taking up one after another the principal points in dispute, he closed with a fervid peroration, in which he drew a striking contrast between the honors which a grateful world had showered upon its greatest benefactor, and the jealousy of the ignoble, the cupidity of the avaricious, who, in less than ten years, had sprung up to rob the inventor of his honor in order to steal his property.

Col. Gantt, of Memphis, had just begun to make the walls shake with the force of his argument for the Pan Electric Co., when an adjournment was ordered to 8 o'clock.

When Col. Gantt at the evening session continued his address, the wisdom of Secretary Lamar in having arranged an evening session instead of hearing the colonel in the afternoon, when the building was full of clerks with work to do, was apparent. It would have been impossible for anyone to work in any part of the building while the colonel was speaking. It was no use closing all the doors. The learned counsel's oratory broke down all barriers and rang through the corridors to the most distant parts of the building, and even startled the passers-by on the street outside. He talked so loudly that he had not covered half of the subject or touched upon half the points at issue, when at 9:45 Secretary Lamar informed him that he had exhausted his allotted time. The points which he elaborated were, that on March 8, 1876, Mr. Baldwin, who, though nominally counsel for Gray, was really having his bread buttered by the "rhinoceros monopoly," had a consultation with Bell and induced Gray, who was not a man of the world, to relinquish his claim, which no honest counsel would have done even if Gray's claim had been as questionable, as it was beyond doubt good and genuine; that it was not in his application filed 14th February, 1876, but in an amendment filed two weeks later that Bell mentioned undulatory electrical currents, which he had stolen from Gray's caveat by favoritism in the patent office; that that amendment embodied what Bell claimed as the essence of the invention, the undulatory continuous current with variable resistance at the point of contact, instead of broken currents described in his original papers; and that that amendment, which was claimed to be the essence of the invention and the soul of the patent, was foisted in and not sworn to.

The first day on which Bell produced an instrument to transmit articulate speech was on May 10, 1876, which he did by adopting the liquid transmitter described in Gray's caveat, but never even hinted at in his own specification. When Bell completed his invention, if he had intended it to be a telephone, or a means of transmitting speech, he would have called it so; but he called it multiple telegraphy. Bell's experts he charged with fraud and with attempting to impose upon the court by presenting as reproductions of Reis's instrument what was quite different. An affidavit by Mr. Van Benthuysen was handed in in contradiction of the affidavit of Frank L. Pope. This was to the effect that the instruments presented on the part of the petitioners were exact copies of Reis's instrument, and were perfect speaking telephones. The Bell company, Col. Gantt said, in the Spencer case, obtained Judge Lowell's decision against the claims of Reis by preventing Prof. Eaton from swearing, for he would have sworn that Reis was the inventor of the telephone which he himself had improved and made to transmit and deliver speech in Brooklyn at least one year before Bell applied for a patent. To say that the Reis instrument was an infringement on the Bell was for a nine-year-old boy to say to his father, "Daddy, you infringe me."

After announcing that briefs may be filed by all who participated in the argument within ten days, Secretary Lamar declared the hearing dismissed.

THE PAN ELECTRIC SKELETON.

The following sketch of the organization of the now famous Pan Electric Telephone Co., is given by Mr. A. B. Talcott, electrician of the House of Representatives. The former electrician of the House was a young man of the name of Rogers, a son of J. K. Rogers, who made himself such a reputation in his card to the New York *Tribune*, wherein he related with such detail how he had distributed the stock of his company in Washington. J. K. Rogers is a very eccentric old gentleman. He has all his life been on the lookout for a fortune through chimerical schemes. His son was the electrician of the House. This son was called a genius by his friends. Mr. Talcott says that he knew very little of practical electricity. It was this son that invented the telephone upon which the Pan Electric company was formed. It is such an infringement of existing telephones that it has never been able to be put up in a single state in the Union. J. K. Rogers is a cousin of Casey Young Atkins, the Indian Commissioner, and of Senator Harris, all of Tennessee. He got these three cousins to go in with him to form a telephone company. This telephone company's capital stock was the genius of young Rogers. The original incorporators of this company paid in $125 cash, no more, and then began to issue stock. Young Rogers sold out his interest to some local people here for $80,000. This fact proves that young Rogers was the genius of the family. He is the only member of the company who has realized any large sum out of the company.

The whole enterprise was based upon nothing except the names of the men who went into it. The parent company has since authorized branch companies in various states in the Union. This is the way these branch companies were organized. The parent company would authorize the formation of a branch with a capital of one or two millions of dollars and would reserve to itself a certain proportion of the branch company's stock. All those who went into the branch company were required to sign a guarantee that they would not sell the stock except at par. The holders of the stock of the parent company were free from any such obligation. Since the formation of the original company, branches have been formed in New Jersey, Illinois, Indiana, Ohio and New York. Garland originally had given to him only 500,000 of this stock, but the increase upon his original stock from the reserves pledged by the branch companies to the parent company, has increased his pile of paper to a nominal holding of a million and a half. This stock must be very lightly valued by the holders of the original issue, for I understand that one of them a few days ago paid $1,000 of it for a week's board. The whole enterprise has the look of a grotesquely transparent scheme. There has never been anything done in the way of actual work beyond the mere printing of stock since the original company was formed. It is understood that the movement upon the part of the Pan Electric people against the Bell Telephone Co., was merely done to put off some of their extravagantly over-issued stock upon the public. Mr. Talcott says that the parent company and its branches have issued between seven and eight millions of stock. That fact alone should create a presumption against the honesty of the Pan Electric company, which owes its entire standing to the fact of its having connected with it the names of a number of officials who have put no money into the enterprise and who have large blocks of stock to sell.

EFFORTS TO INTERPRET THE NEW YORK UNDERGROUND LAW.

The following letter has been sent by Mayor Grace to Mr. Lacombe, counsel to the corporation, regarding the Electrical Subway Commission:

November 14, 1885.

Mr. E. Henry Lacombe, Counsel to the Corporation:

SIR.—I am instructed by the Mayor to ask your opinion on the following question:

Chapter 534 of the Laws of 1884 requires that every corporation, association, etc., owning or controlling telegraph, telephone, electric or other wires * * * shall before the first day of November, 1885, have the same removed from the surface of all streets or avenues in certain cities of this state.

Chapter 499 of the Laws of 1885, which supplement the act referred to, and which was passed on the 13th of June, 1885, authorizes and directs the appointment of commissioners in the cities referred to, who are charged with the duty of enforcing the provisions of the previous act.

Does the wide discretion vested in the commissioners by section four of the latter act, of deciding when and under what circumstances companies may re-

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tain the wires overhead; and does the fact that by section six, the term of office of the commissioners is made to expire on the first day of November, 1887, or sooner, upon the performance of their functions, indicate that the intention of the Legislature was to repeal, by implication, the provisions of the prior act, which directed, absolutely, that the wires be placed underground by the first day of November? Respectfully,

WILLIAM L. TURNER, *Secretary.*

To which the corporation counsel replies as follows:

OFFICE OF THE COUNSEL TO THE CORPORATION,
New York, Nov. 18, 1885.

Hon. William R. Grace, Mayor, etc.

SIR:—I am in receipt of a communication from your office refering to chapter 534, of the laws of 1884, and chapter 490, of the laws of 1885, touching the placing of electric conductors underground, and asking whether in my opinion it was the intention of the Legislature to repeal, by implication, the provisions of the earlier of these two acts, which directed absolutely that the wires be placed underground by the first day of November.

By chapter 534, of the laws of 1884, it was provided that every corporation, association, or person owning or controlling telegraph, telephonic, electric or other wires and cables (including telegraph poles and other appurtenances thereto) should, before the 1st day of November, 1885, have the same removed from the surface of all streets or avenues in every such city. In case of the failure of the owner of the property above enumerated to comply with the provisions of the act within the time specified the "local governments of said cities" were directed to remove, without delay, all such wires, cables, etc., wherever found above ground within the limits of their cities. This act has never been repealed, and, except for such qualification of it as is to be found in chapter 499, of the laws of 1885, it is still in force. By the last cited act it is expressly provided (section 2) that the act of 1884 "is [thereby] amended and made to conform in all respects to the provisions of [the later] act." This later act requires the board of commissioners created thereunder to cause the wires and cables to be removed from the surface and put underground wherever practicable. No express language has extended the time within which the requirements of the earlier act are to be conformed to, and it is, in my opinion, very doubtful whether the provisions of the later act, regulating the course of procedure to be followed by the commissioners in selecting a general plan of underground subways, are so inconsistent with the earlier act as to justify the conclusion that it was the intention of the Legislature to modify it in that regard. This statute will undoubtedly have to be construed by the courts, and as the act of 1885 expressly relieves the city authorities of the responsibility of enforcing the provisions of the act of 1884, a further discussion of the question by the law department would seem to be unnecessary.

I am, sir, yours very respectfully,

E. HENRY LACOMBE,
Counsel to the Corporation.

ELECTRIC LIGHTING IN NEW ENGLAND.

Our traveling correspondent sends the following statistics of electric lighting in Fall River, Mass., and Providence, R. I.:

The Fall River Electric Light Company, using the Thomson-Houston system, has two Armington-Sims engines, 120 h. p., four dynamos, with a capacity of 130 arc lamps. There are in actual use 93 lamps, 25 of which are for public lighting, also a mill plant of 32 lamps.

The Edison Electric Illuminating Company, at Fall River, operates a central station with capacity for 3,400 lamps, and has wired for 2,000, including stores, hotels, theatres, churches and dwellings. Underground conductors are laid in three miles of streets. There are also nine isolated mill plants in operation, aggregating 4,000 incandescent lamps. The system has been in operation two years, and its competition has reduced the price of gas from $2.50 to $2.00 per thousand.

The Rhode Island Electric Lighting Company has a central station at 270 Dyer street, Providence, and uses the Weston system, both arc and incandescent. The power is furnished by two George H. Corliss engines of 200 h. p., each coupled to the same shaft, the belting shafts being connected by internal spur gearing; one Harris-Corliss engine of 80 h. p.; total capacity, 300 arc lamps of 2,000 c. p., or 2,100 incandescent c. p. There are now in use 90 arc lamps on four circuits, 676 incandescent lamps on four circuits, and 96 "mogul" lamps, 125 c. p., each on three circuits, all supplied from arc light dynamos. There are 18 dynamos of 20 arc lamp capacity, each of uniform size, that may be switched into any of the circuits as required. The lights are furnished to private subscribers only. The prices for arc and mogul lamps are 35 cents per night to 7 o'clock, 50 cents to 12 o'clock, and 75 cents for all night; incandescent lamps of 16 c. p., 8 cents each for 12 hours. There are in circuit 17½ miles of No. 4 wire. This plant is in very fine order.

The Narragansett Electric Lighting Company, using the Thomson-Houston arc and the Sawyer-Man incandescent systems, has its station at 52 Aborn street, Providence. Its power is furnished by seven Armington-Sims engines, two of 50 h. p., two of 60 and one of 90, a total of 410 h. p. It has four dynamos, each of 45 arc lamp capacity (1,200 c. p. each), two of 45, 2,000 c. p., seven of 25 and one of 30, a total capacity of 475 arc or 3,800 incandescent lamps. There are now in use 256 arc lamps, of which 75 are for city use, and 480 incandescent lamps, run from arc lamp circuits. The prices to the city are 33 cents per night; to private consumers, 50 cents to 12 o'clock and 75 cents all night. Eight incandescent lamps are furnished at the price of one full arc. The half arcs are furnished at 40 cents per night, or three for $1, up to midnight. They have unfilled orders for 50 more city lamps and 56 incandescents. The plant has been greatly enlarged and entirely refitted within two months, and has been in operation two years.

A NEW TELEGRAPH COMPANY IN MINNESOTA.

Col. W. I. King, of St. Paul, representing the North American Telegraph Company, says:

"The importance of Chicago, Duluth, Minneapolis and St. Paul as grain centres, and the experiences of the people of this city with present facilities, teach the necessity for a new telegraph enterprise in this section. We propose to start and complete as soon as possible telegraph lines from Duluth to Chicago, via Minneapolis and St. Paul. We have had offers from opposition lines which insure our system having the fullest facilities for home and foreign business. Our intention is to build and equip a system with the latest improvements, so that it will be specially adapted to extend the fullest accommodation to commerce. We intend to build it for cash, without any construction company or syndicate, but solely on the basis of stock which has been paid for at the rate of one hundred cents on the dollar. We intend to issue stock to the amount of $200,000, of which $75,000 will be held in the east and will remain under escrow for five years, precluding the possibility of any speculative combinations. Of the remainder we consider that $50,000 should be placed each in Minneapolis and St. Paul, and $25,000 at Duluth. We are offered all the money we want, but we are anxious to interest Duluth particularly, because it does a large amount of telegraph business, and we wish further that they be represented on the Board of Directors. We offer cheaper and more efficient service at rates that will be considerably less than at present."

REPORT OF THE BALTIMORE AND OHIO TELEGRAPH CO.

The indebtedness of the Baltimore and Ohio Telegraph Co. from April 1, 1877, to date, connected with the acquisition and extension of the commercial system, amounts to $3,872,693. This sum does not, of course, include the value of the telegraph lines on the Baltimore and Ohio railroad and branches, and is almost exclusive of the value of the district companies in the cities of New York, Philadelphia, Baltimore, Cincinnati, St. Louis and other points. The Baltimore and Ohio Railroad Co. has received the bonds and stock of the Baltimore and Ohio Telegraph Co. for its advances, and arrangements have also been made for the further extension of its commercial telegraph system. The Baltimore and Ohio Telegraph Co. is thus securely established on an independent and permanent basis. It has made a desirable contract with the Baltimore and Ohio railroad company, for the use of the wires on its system not needed for railroad purposes, and including that system it owns and controls 7,535 miles of poles and 54,972 miles of wire, covering all the leading cities. The policy has been to reach centres of large population, and thus, in the cities of 5,000 or over, it has, through 114 offices, reached an aggregate population of eight millions. The whole number of the company's offices is 1,148. These are at points at which it is believed over 75 per cent. of the entire telegraph business of the country is transacted. The steady and constantly increasing growth of the business of the Baltimore and Ohio Telegraph Co., through its first-class service and the low tariffs established, indicates the appreciation by the public of its value as a competitor to the Western Union Telegraph Co., which has at all times evinced its determined hostility and antagonism. As all the leading cities have now been connected by a complete and perfect system, the Telegraph company will be enabled to effect material reductions in its operating expenses, and the board feel confidence in expressing the belief that the enterprise, which they have thus so successfully fostered and developed, will, aside from public considerations and its business value to this company, prove a most remunerative investment.

TELEGRAPHERS' MUTUAL BENEFIT ASSOCIATION.

The annual meeting of the Telegraphers' Mutual Benefit Association was held in the Western Union Building, Nov. 19. Officers as follows were elected: A. R. Brewer, president; William H. Young, vice-president; Charles P. Bruch, secretary; E. T. Mackay, treasurer, and the executive committee as given were J. Merrihew, Joseph Uhrig, J. L. Edwards, C. W. Hammond and W. B. Gill. Receipts for the year were $76,105.43, and disbursements $66,872.13, leaving a balance on hand of $9,233.30.

ELECTRIC LIGHT AND POWER.

The Central Edison Light Company has been incorporated at Covington, Ky., by Henry Worthington, Archie Steward and H. H. Hoffman, to furnish heat, light and power by electricity; capital stock, $100,000.

The Electric Light and Power Company has been incorporated at Fort Worth, Texas, to establish electric light works, with a capital stock of $25,000.

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The Steam Pump Company, Holyoke, has placed electric lights in its foundry department. The entire works are now lighted by electricity.

William Stanley, Jr., has leased the old Day rubber factory at Great Barrington, Mass., and is fitting it up as a laboratory to be used in the development of his inventions in the interest of the Union Switch and Signal Company of Pittsburg.

A company to be known as the Worcester Electric Power Company has been organized at Worcester, Mass. Mr. S. E. Hartban is general superintendent of the company. They purpose to introduce into Worcester the electric transmission of power for the operation of machinery for manufacturing purposes, and also for the operation of street cars.

MANUFACTURING AND TRADE NOTES.

The Washburn & Moen Company, Worcester, has recently enlarged its property by the purchase of 30,000 feet of land adjoining the south side of its works. The directors have voted to adopt the weekly payment system after January 1. They employ about 3,000 hands.

The Narragansett Machine Company received the second award for collective exhibition of foot-power machinery. They have a new screw cutlery lathe that is a favorite with electricians.

Jones, Denton & Co., contractors on the new aqueduct for New York, report that they recently ran a Westinghouse engine and a Ball dynamo thirty-six days without a stop, in lighting their tunnel work.

The Westinghouse Machine Co. have within the last thirty days shipped for electric lighting alone the following Westinghouse engines: Brush Electric Light Co., of Buffalo, three of 60 h. p. each, making the fifteenth order from that company; Toledo Electric Light Co., 65 h. p.; Cleveland Electric Light Co., a fifth order for 60 h. p.; Oshkosh Gas Co., for electric lighting, 50 h. p.; W. D. St. Clair, Chicago, one 50 and one 35 h. p.; George D. Sheibly, Fostoria, Ohio, 35 h. p.; The Pittsburgh Club, 35 h. p., with a complete incandescent plant, besides about twenty smaller engines to private parties.

PERSONAL MENTION.

Senor Don Saturnino Yslas, an electrician well known in America, has just been made director general of national telegraphs of the Republic of Mexico.

Mr. W. E. Huntington has been appointed general superintendent of District Telegraph Service of the Baltimore and Ohio Company, with headquarters in New York city.

THE TELEGRAPH.

The plant of the Postal Telegraph Company, including all its fixtures and all the wires underground and overhead within the District of Columbia, was sold at auction November 5 by United States Marshal McMichael, to satisfy a deed of trust. The only bidder was Mr. Hillyer, acting for Mr. S. C. Elliott, the plaintiff in the suit, who bought the property for $4,000. The judgment was for $10,000. It is said the underground wires alone cost the company $20,000.

The Arkansas Telegraph Company began building from Malvern to Little Rock on November 14, along the Iron Mountain road, when a construction train carrying fifty men arrived and tore down all the poles and wires, and drove the telegraph men from their work. On Nov. 16 R. E. Douglass, president of the Arkansas Telegraph Company, set his men to work building from Little Rock to Malvern, when the fifty men again arrived and destroyed the work as fast as it was done. Mr. Douglass was told that he positively could not erect his poles along the right of way of the Iron Mountain railway, and that 400 men were ready to prevent him doing so. He withdrew his force to prepare to call upon the authorities to protect him. The people will demand that the militia be called out for his protection.

SUBTERRANEAN LINES.

The Dorsett Underground Service Company has been incorporated, the object being to lay electric conduits in Milwaukee. The capital stock is $500,000, and the incorporators are Thomas Shea, A. W. Hall and Paul Bechtner.

SUBMARINE CABLES.

The cable connecting Nantucket with Martha's Vineyard was successfully landed at noon November 19.

INVENTORS' RECORD.

Prepared expressly for THE ELECTRICIAN AND ELECTRICAL ENGINEER *by* Pope & Edgecomb, *Solicitors of Patents for Electrical Inventions*, 11 *Wall Street, New York city.*

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From October 20th, to November 10th, 1885 (inclusive).

Alarms and Signals:—*Signaling Apparatus*, I. H. Farnham, 328,578, Oct. 20. *Gong*, J. P. Tirrell, 328,982, Oct. 27. *Central Office Apparatus for Fire Alarm Telegraphs*, L. H. McCullough, 329,186. *Non-Interfering Fire Alarm System*, same, 329,187. *Testing Apparatus for Fire and Police Telegraph*, same, 329,188. *Non-Interfering Fire and Police System*, same, 329,189. *Indicator for Letter Boxes*, E. E. Weaver, 329,245; Leo Ehrlich, 329,294. *Automatic Fire Alarm Telegraph*, M. Morris and J. C. Wilson, 329,468, Nov. 3. *Signaling Apparatus for Machinery*, M. W. Grovesteen, 329,830. *Thermometric Alarm*, John Barry, 329,698. *Call Box*, Frank B. Wood, 329,871. *Alarm for Locomotives*, W. Vogel, 330,074, Nov. 10.

Clocks:—*Speed Clock for Machinery*, W. H. Lord, 328,592, Oct. 20. *Clock*, F. R. Field, 328,769. *Time Detector*, T. Ahearn, 329,874, Nov. 10.

Conductors, Insulators, Supports and Systems:—*System of Electric Lighting*, T. A. Edison, 328,573, 328,574, 328,575, Oct. 20. *Conduit*, G. B. Pennock, 328,712; H. L. Caples and W. W. Lewis, 329,887, Nov. 10; T. D. Williams, 330,277. *Insulator*, L. O. Smith, 328,728; W. N. Fawcett and G. F. Huntley, 328,929, Oct. 27. *Street Curb and Gutter*, Geo. D. Sutton, 329,342, 329,343, 329,-344. *System of Distribution*, H. M. Byllesby, 329,621, Nov. 3. *Conductor*, A. C. Tichenor, 330,071, Nov. 10. *Means for Supporting Wires*, J. W. Tringham, 330,173.

Dynamo Machines and Motors:—*Floating Current Motor*, William Main, 328,496, 328,497, 328,593, Oct. 20. *Commutator for Dynamo*, C. E. Piper, 328,-859; T. A. Edison, 328,572. *Dynamo*, C. M. Ball, 329,118, Oct. 27; E. P. Clark, 330,095, Nov. 10. *Regulator for*, W. M. Schlesinger, 329,681, Nov. 3; C. E. Scribner, 330,053. Nov. 10.

Galvanic Batteries:—*Liquid for*, A. F. W. Partz, 328,607, Oct. 20. *Battery*, T. L. Kauffer, 328,687, Oct. 20; 328,948, Oct. 27. *Earth Battery*, G. F. Dieckmann, 329,724, Nov. 3.

Ignition:—*Gas Lighting Device*, D. Rosseau, 328,976, Oct. 27. *Gas Lighting Burner*, same, 328,977. *Testing and Firing Apparatus for Submarine Mines*, J. P. Gibbins, 330,226, Nov. 10.

Lamps and Appurtenances:—*Incandescent Lamp Switch*, C. R. Arnold, 328,831, 328,832, Oct. 20. *Arc Lamp*, A. G. Holcombe, 329,166, Oct. 27; H. Lemp, 329,461, Nov. 3; G. C. Pyle, 329,948, Nov. 10; C. E. Scribner, 330,053, 330,055; O. Romanze, 330,351. *Support for Lamps*, C. L. Travis, 329,510. *Holder for Incandescent Lamps*, C. H. Benton, 329,618; W. Stanley, Jr., 330,-269, Nov. 10. *Process of Obtaining Carbon for Incandescents*, S. Nicholson and H. A. Bowen, 329,670, Nov. 3. *Regulator for Lights*, P. Lange, 330,2[illegible] Nov. 10.

Metallurgy:—*Apparatus for Separating Gold from Ores*, W. J. Tanner, 328,-532, Oct. 20.

Miscellaneous:—*Joint for Wire, Cables, etc.*, C. G. McLeod, 328,502, Oct 20. *Governor for Water Wheels*, E. H. Amet, 328,556. *Perforator*, J. E. Munson, 328,600. *Switch*, S. S. Leonard, 328,695; H. Lemp, 329,460, Nov. 3. *Belt*, P. Wenigmann, 328,829, Oct. 20. *Filtering Apparatus*, G. H. Moore, 329,064, Oct. 27. *Cable Conveyance*, C. J. Van Depoele, 329,104, Oct. 27. *Governor for Steam Engines*, P. W. Willans, 329,112. *Wire Clamp and Coupling*, E. M. Hamilton, 329,162. *Mechanism for Operating Safe Bolt Work*, F. Sedgwick, 329,222, 329,223. *Medical Battery*, T. H. Hicks, 329,310. *Circuit Controlle.*, W. A. Leggo, 329,398, 329,399. *Manufacturing Thermostats*, M. Martin, 329,-469, Nov. 3. *Thermostatic Electric Controlling Device*, same, 329,470. *Burial Casket*, C. Sieber and F. H. Borntraeger, 329,495. *Compound Magnet*, S. H. Parkes, 329,708. *Induction Coil*, T. J. Perrien, 329,772. *Electric Magnet Armature*, J. Steiner, 329,782. *Circuit Breaker*, C. L. Bruns, 329,808. *Medical Apparatus*, A. Metzger, 329,929, Nov. 10. *Machine for Covering Wire*, J. McCahey, 330,035. *Spool Carrier for Winding Machines*, same, 330,036. *Automatic Circuit Closer*, P. C. McCambridge, 330,037. *Cable Armoring Machine*, W. R. Patterson, 330,047. *Method of Testing Cables*, same, 330,048. *Splice for Underground Cables*, same, 330,049. *Testing Apparatus for Lightning Arresters*, C. E. Scribner, 330,054. *Laryngoscope*, C W. Meyer, 330,139. *Carbon Electrode for Electrolytical Purposes*, H. Leipmann, 330,247.

Protectors:—*Electrical Apparatus Protector*, C. F. Elden, 329,152, October 27. *Protecting Structures from Lightning*. 329,853, Nov. 3.

Railways and Appliances:—*Electric Railway System*, F. J. Sprague, 328,-821, Oct. 20. *Signal*, H. C. Nicholson, 329,478, Nov. 3.

Telegraphs:—*Printing Telegraph*, C. N. Judson, 328,491, Oct. 20; W. J. McCausland, 328,500; S. B. Van Nortwick, 329,515, Nov. 3. *Apparatus for Maintaining Communication with Moving Vehicles*, L. J. Phelps, 329,076, 329,-077, Oct. 27. *Automatic Harmonic Recorder*, E. Gray, 329,386. *Multiple Local Circuit for Telegraphs*, F. L. Pope, 329,410. *Multiple Local Circuit for Electric Telegraphy*, same, 329,411. *Multiple Local Circuit for Electric Telegraphs*, same, 329 412. *Means for Adjusting Submarine Duplex*, A. Muirhead, 329,477, Nov. 3. *Siphon Recorder*, W. Dickenson, 326,723. *Means for Preventing False Signals on Reversals in Quadruplex*, J. W. Larish, 329,749. *Transmitter for Printing Telegraphs*, 330,2[illegible]8, 330,239, Nov. 10. *Telegraph Instrument*, G. W. Stewart, 330,271. *Automatic Perforating Telegraph*, J. E. Munson, 330,344.

Telephone Systems and Apparatus:—*Switch-board*, C. C. Sonne, 328,618, Oct. 20. *Telephonic Appliance*, J. F. McLaughlin, 328,702. *Transmitter*, same, 328,703. S. E. Beedy, 329,001, Oct, 27; F. D. P. Marstow, 329,827. *Telephone*, T. A. Edison, 329,030; J. H. Robertson, 329,084, 329,085; W. A. West, 329,983, Nov. 10. *Telephone Receiver*, J. H. Robertson, 329,083. Oct. 27. *Telephone Call Register*, A. S. Hibbard, 329,646, Nov. 3. *Sound Concentrator for Telephones*, J. Godfrey, 329,732. *Telephone Cabinet*, F. G. Johnson, 329,909, Nov. 10. *Combined Telegraphic and Telephonic Circuit*, A. M. and T. R. Rosebrugh, 329,956. *Receiver for Telephonic Telegraphs*, W. A. West, 329,982. *Telephonic Telegraph*, same, 329,984. *Battery Circuit for Exchanges*, C. E. Scribner, 330,056. *Exchange Signal*, same, 330,057. *Operators' Apparatus for Exchanges*, same, 330,058. *Multiple Switchboard Testing Apparatus*, same, 330,059. *Operators' Testing Apparatus for Multiple Switchboards*, same, 330,060. *Multiple Switchboard*, same, 330,061, 330,062; J. A. Seely, 330,067. *Operators' Apparatus for Switchboards*, C. E. Scribner, 330,-063. *Gravity Telephone Switch*, same, 330,064. *Exchange Switching Apparatus*, same, 330,065. *Toll Line Apparatus for Exchanges*, same, 330,066.

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